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CLINICAL RESEARCHES

ON

AUSCULTATION OF THE RESPIRATORY ORGANS,

AND ON THE

FIRST STAGE

OF

PHTHISIS PULMONALIS.

BY JULES FOURNET,
INTERN OF THE HOSPITALS, PARIS, ETC.

A WORK WHICH OBTAINED THE PRIZE AT THE CONCOURS OF THE HOSPITALS OF PARIS IN 1837.

Translated from the French,

BY THOMAS BRADY, M. B.
FELLOW AND PROFESSOR OF MEDICAL JURISPRUDENCE IN THE KING AND QUEEN'S COLLEGE OF PHYSICIANS, IRELAND.

PART I.

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LONDON:
JOHN CHURCHILL, PRINCES STREET, SOHO.
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TRANSLATOR'S PREFACE.

THE *part* of M. Fournet's work which is here presented to the English reader, contains his *researches on auscultation*. Though chiefly directed to the diagnosis of phthisis, and having constant reference to the second part of the work, it forms a tolerably complete system of auscultation of the respiratory organs, in which, while some errors, sanctioned by the authority of Laennec, are rectified and some omissions supplied, most of the physical phenomena are considered in a point of view somewhat different from that in which they were contemplated by the great discoverer.

If we examine with attention the history of auscultation, we will, I think, be convinced that its progress has been greatly retarded, and its advantages hitherto confined to a particular class of cases, chiefly from the mode in which it has been studied. In the usual mode of study, the ear, accustomed from the first to certain obvious and easily recognized sounds, which often afford conclusive evidence of the condition of the lungs, becomes insensible or indifferent to slighter and less distinct impressions; while the mind, instead of viewing the physical signs as forming a part of the facts upon which its conclusion should be founded, is unconsciously habituated to look at them rather in an independent point of view, and to consider them, when recognizable at all, as in themselves alone sufficient to establish the diagnosis. Hence the exaggerated importance attached to pectoriloquy, bronchophony, cavernous respiration, &c.; hence the more delicate signs, that mark the first inroads of disease, have been altogether neglected; hence the *expiratory* murmur was so long unnoticed or forgotten. This mode of viewing the physical phenomena may be said to have originated with Laennec himself, a
has continued more or less to influence observers ever since. W

case of Laennec, indeed and men of his stamp, familiar with all the features of disease and whose views were in general profound and comprehensive, the erroneous direction thus given to the mind probably produced in practice no other ill effect than depriving them of some important diagnostic signs; but it was otherwise with persons of inferior capacity, and perhaps with the majority of students. With them an undue confidence in physical signs has unfortunately often led to mistakes in diagnosis, the result of which has been doubt, distrust, and at length total abandonment of auscultation, or perhaps what was worse, the practice of appealing to it without any faith in its responses. From the same cause has originated the reproach which is sometimes with too much reason addressed to auscultation: that it is silent at the period when it might be serviceable, and only reveals the disease when it is no longer remediable either by art or nature.

The new method followed by M. Fournet in the study of auscultation must lead to happier results. Attention is here first directed to the attainment of a familiar acquaintance with the normal respiratory sounds. This is the natural course, and its advantages are so obvious that most writers have recommended it; but the old system tended rather to divert the mind from this study, which on the other hand, forms an essential and indispensable part of the new. A careful analysis of the properties of these sounds brings under notice different sonorous phenomena hitherto neglected, whose modifications in disease furnish a number of new diagnostic signs. The constant existence of an *expiratory* vesicular murmur both in health and disease being recognised by M. Fournet, its physiological characters are studied with the same minuteness as those of the inspiratory, and another new source of diagnosis found in their morbid modifications. Let me observe, that while in this study of the properties of the normal murmurs, the ear acquires a perfect familiarity with these sounds, it must at the same time attain a delicacy of perception which will enable it to recognize the first deviations produced by disease; nor is this study calculated to foster a false confidence in physical signs; but on the contrary, from the delicacy of the phenomena and the difficulty of appreciating them, it will probably suggest to every mind the danger of relying on them alone, or of contemplating them in an isolated or independent point of view; the necessity of always considering them in their relations with e [illegible], and in connexion with all the other signs, symptom [illegible] l phenomena.

[illegible] udy of the two periods of respiration naturally suggested the idea of determining with which of them each morbid sign co-exists, and from this source a number of new differential characters is derived. Lastly, the combinations of the physical phenomena with each other, the relations that connect them together, their natural or accidental course and the successive transformations of some of them, have been carefully studied, and a number of general facts thus established, of considerable use in the diagnosis and prognosis of certain diseases.

It is in reference to phthisis that the defects of the usual mode of studying the physical phenomena appear particularly conspicuous. Most practitioners are familiar with the physical signs of this disease at the period when its diagnosis is scarcely of any use; few have studied them at the period when any benefit might be hoped for from remedial measures. It is in phthisis also that the method of M. Fournet may be expected to produce its happiest results. Its advantages are strikingly illustrated in the second part of this work, in the diagnosis of the earliest stage of the disease. But as this first part is complete in itself, and as it is, in my opinion, the most useful guide in the study of auscultation that has yet appeared, I thought it better publish it at once, intending to follow with the other part with as little delay as possible.

Dublin, August, 1841.

M. Fournet has given a new character of precision to many phenomena already imperfectly known, added some new ones, and taken a more complete and philosophical view of the system of respiratory signs than any previous author. He has pointed out the route in his diligent investigations of the two murmurs, to, we doubt not, numerous important additions to semeiology, and taught us how much remains unexplored in this, as was hitherto supposed, almost exhausted field. * * * * He has assuredly himself learned the means of detecting consumption earlier than his predecessors; some cases of the affection diagnosticated in the very incipient stage (and correctly, as the event proved,) drew this admission from some of the members of the Academy of Medicine.—*British and Foreign Quarterly Review,* No. XVIII. page 342.

PREFACE.

The researches contained in this work are directed to two objects. 1°. the auscultation of the respiratory organs conducted upon principles different from those that guided Laennec; 2°. the history of the first stage of phthisis pulmonalis considered under various points of view: the causes capable of producing it and favouring its developement, its curability in its first and last stages, the diagnostic signs of its first degree, and the treatment, as well prophylactic as curative, suited to it.

If a new direction had not presented itself for my researches, if I had not perceived the possibility of considering these subjects under other points of view than those of the great masters who had gone before me, I would not have ventured upon any attempt after them; still less would I have hoped, after the beautiful works they have left, to arrive by my own investigations at new results which, perhaps, will not be deemed altogether undeserving attention. Should it be so, should any merit belong to a work which has at least that of being conscientious, the greater part of it is due to M. Andral, since it is to his good opinion, to his generous kindness, I am indebted for the favourable position I occupied for making these researches.

I have divided this work into two parts: the first contains my researches on auscultation, the second my researches on phthisis.

1°. The analysis of the two murmurs of respiration (inspiratory murmur, expiratory murmur), instead of the single murmur described by Laennec, has multiplied the number of signs by means of which we recognize the diseases of the respiratory orga
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exist. The analysis of a greater number of the properties of sound than Laennec noticed, has enabled me to ascertain a greater number of morbid modifications of the respiratory murmurs, to establish new relations between the symptomatology and pathological anatomy, and to multiply, by this new means, the signs of the diseases of the pleura, of the lungs, &c. The determination of the law of coexistence of the morbid sonorous phenomena of the respiratory apparatus with inspiration or expiration, has served also to increase the number of these relations and of these signs. Lastly, the more exact order, the more full conception, the more fixed principles that have directed the whole of this new study of auscultation, will, I hope, have the effect of making better known the relations that connect together a great number of these phenomena, the successive transformations of several of them, their natural or accidental course, in a word, the laws that govern them, and, consequently, of rendering more easy and more useful their application to the diagnosis, to the prognosis, and therefore to the treatment of the maladies of which they are signs. These auscultatory researches will also, in many instances, have the advantage of rendering the diagnosis of certain diseases possible at a period of their course at which it was hitherto impracticable, the period of their commencement, which is the most favourable for their treatment.

2°. With respect to the considerations that directed my researches on phthisis pulmonalis, they were: 1°. to determine what are the chances of the curability of this affection; 2°. to deduce the treatment from the data furnished by the etiology of the disease, that is, to make *hygiène* its principal basis, for pharmacology has hitherto only served to confirm the melancholy presentiment of the *absolute* incurability of phthisis; 3°. to apply this treatment to the first stage of the disease, the only one during which it can be in any way successful, and, for this purpose, to investigate the diagnostic signs of this first stage.—Now I hope I have demonstrated: that the general opinion of our age, as to the cure of phthisis in its third stage, *by means of the cicatrization of cavities*, is not accurate; that the opinion of the incurability of phthisis in its first stage is not founded on any solid reasons; that on the contrary, there is every reason to think that the result of the treatment of this affection, if managed upon certain principles, ought to be: 1°. in some individuals, to prevent the developement of phthisis with which they are menaced; 2°. in those who are actually affected with it, and who have recourse in time to the aid of medicine to remove, in some, all local traces of the disease; and, in many others, to arrest its progress, so that the patient lives, retaining however in his lungs the vestiges of the disease. In all cases, the only treatment that can have any success is that which consists chiefly of prophylactic measures, by which we oppose, sometimes the first appearance, sometimes the increase of phthisis. From its very nature, this treatment must be derived chiefly from hygiène, and be indicated by the etiology of phthisis; its chances of success must be proportioned to the space of time longer or shorter, that has elapsed since the commencement of the affection. Now, I venture to hope that my researches on the cause of phthisis will contribute to guide the treatment in this preservative course, and that my researches in diagnosis will enable us to apply it to the first stage of phthisis, at least in the greater number of cases. If I have attained the latter object, which I hope will be admitted, surgery will also derive great advantage from it, for the surgeon will not be so often exposed to endanger the life of the patient by calling into activity, by his operations, tuberculous affections till then unfelt and stationary, nor to risk his own reputation and that of his art by failures due to the unfavourable condition in which the patient happens to be.

The new course I have followed in the study of auscultation, is one of the sources from which I have derived the signs of the first stage of phthisis; in this point of view, a knowledge of the first part of the work is indispensable, in order to understand and appreciate what, in the second part, relates to this diagnosis. I am obliged to offer this warning to persons who, thinking they had no interest except in the second subject of this treatise, might consider the study of my researches on auscultation useless to them. To be able to recognize the signs I point out, it is necessary to be accustomed to the mode of auscultation I have developed in the course of the first part; it is necessary to have educated the senses in this particular point of view; it is necessary that the mind be prepared for the new relations I have established amongst the facts; but how place oneself in these conditions by any other means than a full knowledge of the principles and facts I have established? I repeat it, those who choose to judge the results I announce in the present state of their senses and their minds, and who will not take the trouble to follow step by step the course I have adopted, to renew their education in auscultation, these men will not be in a condition to form a just opinion. In a word, I am the first to challenge an examination of the facts I have brought forward, but I demand that this examination be *serious*; for clinical observation gives always the same answer when it is properly interrogated. I think I should also warn the reader, especially in reference to the second part of this work, that the facts contained in it are of such a nature, and are so dependent one upon the other, that it is not possible to form an accurate idea of the value of each, except after reading all, and analyzing the whole assemblage of them. I may have fallen into errors; how can I expect to be secure from them, after having myself pointed out several in Laennec? but of this I am convinced, that no one could undertake the work with more desire of truth, with greater impartiality in his researches; no one could make greater efforts to attain this end. My original cases are taken at great length; when the facts with respect to which I interrogated the patients did not exist, I noted their non-existence with as much care as their existence in the opposite case; the autopsies are reported with the same detail; so that I have been able to establish accurate relations between the morbid alterations, and the different circumstances of the history of the disease. It is these relations, often observed, that have authorized me to elevate to the rank of signs, several of the phenomena that had been noticed during life. It is by the same process that I have arrived at the knowledge of the general facts which are scattered here and there in the course of the work. Knowing by experience how difficult it is to obtain accurate information from patients, I have taken the utmost pains in questioning them, not passing from one question to another till I had reason to believe, that the answer of the patient was an accurate representation of the fact. Lastly, in order to have, in the testimony of others, the certainty that my senses had not deceived me, I often requested M. Andral to ascertain whether the phenomena were such as I had seen or heard them; or I asked other persons well versed in clinical practice, who usually attended the hospital, to do the same. I dwell on all these circumstances, because it is to them we must look in investigating the cause of the relations true or false that have been established between the facts.

The cases of phthisis pulmonalis on which the second part of this book is founded, are 192 in number. Those that supplied me with the auscultatory facts contained in the first part, are much more numerous, for all the cases of disease of the thoracic organs that I have noted during the last four years, have been taken with a view to those researches. Being obliged, however, to confine myself within certain limits, I have given only a small number of cases in the course of this work. Those introduced here and there in the text, are in general given with little detail; I have only retained the circumstances that establish the fact with respect to which they are brought forward. The five cases which terminate the work are the only ones that have been reproduced, with almost all their primitive developements; the reasons that determined me to act thus will be seen at the commencement of Chapter XVII., Part 2nd. These cases will be found to present very striking examples of phthisis recognized in its first stage. As several of the general facts announced in the course of this work are of considerable importance, and that one cannot rest satisfied with merely stating them, I intend to enter into a detailed explanation of them in separate *memoires*, when at least I can make use of my cases.

The diagnosis of the first stage of phthisis is, in general, composed of very numerous, and sometimes very complex elements. It is not, therefore, on the results of auscultation alone I rely in forming this diagnosis, as some persons have imagined. So far from this, nothing is, in my opinion, more certain, than that we must necessarily commit many errors if we presume to judge from one class of signs alone, and from their *absolute value*, instead of considering all together and their *relative value*. I dwell upon this fact, in order that persons may not impute to a want of value in the signs I point out, mistakes which result from their not being properly appreciated. In the diagnosis of the first stage of phthisis, as in every diagnosis, there are different degrees of certainty, which vary according to the different conditions of the patients; but, in the greater number of cases, an accurate diagnosis may be formed, sometimes even it may be attained at the period when phthisis consists in a certain general disposition only, and when the tuberculous matter has not been as yet secreted either in the lungs or in any other organ.

There are persons who will treat as *minutiæ*, some of the auscultatory facts that concur to the diagnosis of the first stage of phthisis. The importance of the result obtained by these pretended minutiæ, would be in itself a sufficient answer; but we may observe to persons who thus accept the result, and seem to wish to reject the means, that their reproach is not logical, for alterations so slight as those with which phthisis commences, can produce very slight symptoms only, inasmuch as the degree of the symptom expresses the degree of alteration; we must, therefore, be prepared to find the signs more delicate in proportion as we choose to approach nearer the commencement of the malady. Besides, let me remark, that those signs which will probably appear of extreme delicacy and difficulty to physicians little habituated to auscultation, are very sensible and very distinct to those whose senses have, by constant practice, acquired peculiar delicacy; consequently, it is a question of persons rather than of facts, and therefore admits not of discussion. We know the incredulity and the conflicting sentiments with which the first discoveries of Laennec were received, and we know whether much of this incredulity exists now. The utility of some of my auscultatory researches may be contested with more show of reason, on the ground that they only lead to a kind of superfluity of diagnosis. I admit, that in ordinary cases it would be useless to avail oneself of some of the signs I have pointed out in my first part. But there are other cases where the diagnosis of certain affections of the chest is very obscure, where the general signs are serious, the progress of the disease alarming, the mind undecided as to the seat, the degree, the course, sometimes as to the nature of the malady, and consequently as to its treatment; in such a case will we not eagerly welcome the same signs which were rejected as superfluous in happier circumstances? Does the chymist or natural philosopher neglect the most trifling phenomena, when they are of a nature to throw light on the facts he investigates? Do we ever complain of the richness of a language? Now, in the point of view in which the sciences were regarded by Condillac, is not semeiology the language from which we derive, and from which we ought to derive all our inspirations?

The first part of this work presents a system or general plan of auscultation nearly complete; at the same time, the reader must not expect to find in it all the facts that constitute the domain of auscultation of the respiratory organs. My object was only to lay before him the new auscultatory facts to which I have been conducted by my researches, to rectify some errors that escaped Laennec, and to present some of the facts he described, in the peculiar point of view in which those researches enabled me to contemplate them. I have on several occasions been obliged to criticise Laennec; but I declare, that no one can feel higher admiration for his labours, nor greater respect for himself, even looking at his mistakes, for these mistakes themselves are proofs of the active and energetic character of his mind.

To avoid too frequent repetitions, I have employed the words *inspiration* and *expiration*, as synonimous with the words *inspiratory murmur*, *expiratory murmur*. It will be easy from the context to distinguish whether the former are used in their proper or synonimous sense. The words *cells*, pulmonary *vesicles*, also occur in many places; it is not that I wish to pronounce any opinion as to the nature of the texture of the lungs; these words are only employed for the want of better, to indicate the seat of certain sounds, or certain alterations in the terminations of the bronchial ramifications. The word *law* which I also employ sometimes, might seem ambitious to some, if I did not state that I merely use it as a brief expression of the following thought: *the general fact governs a certain number of particular facts.*

It was in 1835, at the Hotêl-Dieu, Paris, I commenced the researches contained in this work; I continued them afterwards at the hospitals la Pitié and la Charité. Since 1836 I have constantly given clinical lectures on the two subjects of my labours, and on the results at which I had arrived. These lectures were attended chiefly by physicians from other countries, who having heard of my researches, did me the honor to desire to see my clinical practice. They have often urged me to publish this work, and to use their testimony as evidence of the accuracy of the facts it contains, of the ease with which each was able to verify those facts by following the course and method I pointed out, and of the advantage they derived, in the study of auscultation, from the general facts in which I have included a certain number and certain classes of particular facts. Several of these physicians requested me to state that they had attended my lectures; I comply with their wish, and at the same time produce them as witnesses by inscribing here those who have left me their names.*

In conclusion, let me add, that the manner in which these researches have been received by the Academy of Medicine† and by some distinguished individuals, and the opinions expressed to me on this subject, induce me to hope that some good will result from my labours. Thus, looking to the second subject alone of this work, consumption, may we not anticipate that in the full and circumstantial account of the causes of this malady will be found a copious source from which practice will derive its best indications, and from which must flow valuable results? May we not hope that the possibility of acting in the earliest period of phthisis, sometimes even before the local disease is formed, will hereafter afford medicine a fair prospect of success? Perhaps, too, these researches may make a salutary impression on the minds of that enlightened portion of society that gives an impulse to the rest: perhaps I may have succeeded in showing the barren and mischievous consequences of the opinion that consumption is absolutely incurable; perhaps I may succeed in impressing on those threatened with consumption the deep interest they have to watch the first derangement of their health, and to seek at once the aid of medicine. Perhaps, with the causes of the malady, I may have pointed out to some the means of avoiding it. I venture to hope also that those to whom, on account of their ability, the people confide the public interests, will find in the results of these researches valuable data for sanitory measures both legislative and administrative.

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* The author gives here a long list of physicians of different countries, among whom I find the following English:—

DRS. FETHERSTON, Newcastle, Northumberland; NEISSER, London; ROSS, London; POWER—CLARKE—COLAHAN, Ballinrobe, Ireland.

† Seance de l'Academie Royale de Medecine, du 13th Mars, 1838.

PARIS, 1st *May*, 1839.

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CORRIGENDA.

Page 27; *for* Part I. *read* Article I.
Page 55, line 34; *for* enable, *read* lead.
Page 214, line 5; *for* Laennec, *read* Lancette.

CLINICAL RESEARCHES, &c.

FIRST PART.

RESEARCHES ON AUSCULTATION OF THE RESPIRATORY ORGANS.

INTRODUCTION.

In 1816 the immortal Laennec opened a new career to the science of diagnosis. From the first he comprehended all its extent; while his powers of observation, which equalled the facility and accuracy of his understanding, enabled him subsequently to traverse it in almost every direction. In a very short time he had collected around him immense materials; and upon this mass of facts, so new, so numerous, so diversified, but of whose value the accuracy of his senses assured him, he poured the light of analysis. Similar facts were brought together, their relations recognized; a common chain united them, order succeeded to confusion, science laid hold of what seemed at first a mere object of curiosity, and auscultation was created. The impulse that acted on Laennec was felt by other men in his own time and since. At his side M. Andral, inspired with the same foresight, animated with the same force, attained the same end. At times Laennec even seemed annoyed by the too close proximity; but this passing weakness only tended to the advantage of science, by exciting him perhaps to still greater activity. Similar men soon took the same path: accurate and well-trained senses, a sound judgment applied to the analysis of facts, confirmed the results of Laennec, and even penetrated beyond him. Observers of a different stamp mingling with the former, laboured in various ways in this new field of science; and auscultation, great even in the cradle, fruitful from its birth, was hailed on all sides with the enthusiasm and the unanimity reserved for truth. Some minds, always slow to follow the progress of their age, generally rebellious to every discovery, obeyed as usual their instinct of opposition; but their conversion, which could not be long delayed, was a homage to auscultation, or the new science passed easily over this obstacle. (1)

But so much space could not be traversed in so short a time, without some mistakes and some omissions. The mind, full of its progress and its object, had not taken time to reflect sufficiently on the point from which it started; hurried along by the force of circumstances, distracted by the number and variety of phenomena, it neglected in its route some important elements of the problem, and hence the solution was incomplete in some points, inexact in others. Besides, in this rapid movement, it was difficult to preserve an equally vivid impression of all the relations of the facts, and it was impossible to arrive at the knowledge of all the laws that govern them.

For a long time Laennec, exercising around him that invisible influence, that fascination which belongs to genius, maintained within the limits he had traced, the science of his creation; hurried on by the impulse he had communicated, men continued to follow in his track without almost thinking of the principles that had guided him; without seeking to extend or even to analyse those principles. For some time past, however, even those that belonged to the first movement, and still more, some new men have returned upon the route of Laennec, and have succeeded in discovering some useful facts, which his prepossessions and the rapidity of his progress prevented him from seeing.

Devoted for many years, by position and by taste, to a profound study of clinical facts, I was fascinated by the career of Laennec the moment I became acquainted with it. I set about traversing it with the same zeal as if I were the contemporary and pupil of that illustrious master. I did so with a three-fold object:—1st. to arrive more quickly and more perfectly at the practical application of the discoveries of Laennec, by finding out by myself all the facts he had ascertained; 2nd. to subject them, one by one, to a rigid analysis, in order to recognize their exact value; 3rd. to extend, if possible, the domain of these facts. With senses perfectly unprejudiced and well trained; with a mind free from all foreign influence, and from all personal interest, one might hope to attain this object. I endeavoured to place myself in these conditions. I sought, in the first place, by associating with those who had specially cultivated this subject, to give my senses that delicacy and that accuracy which was necessary to enable them to proceed subsequently alone; after the example of those men, I endeavoured to make the operations of the senses always precede those of the mind, and to place both under the control of that precious faculty, attention, which, in watching their operations, is the guarantee of their results. Placed sufficiently remote from the sphere of Laennec's activity, to be unaffected by the influence he exercised around him, I could, in reflecting on the route I had to traverse, see what had been done, ascertain what remained to be done, and so arrange beforehand the object and the means. My position as intern of the hospitals, the friendship of my masters, by placing at my disposal a great number of patients, afforded me full opportunity for such researches. It was in the beginning of 1835, at the Hotel-Dieu, I commenced my labours. Pathological anatomy, inseparable from symptomatology, formed an essential part of them.

1. In listening attentively to the respiratory murmur in persons whose chests were healthy and well formed, I was astonished to hear two sounds, instead of the single one described by Laennec. I verified however the accuracy of this first result, and saw, *that, in the normal state, inspiration and expiration were each accompanied by a very distinct murmur;* the latter being merely much weaker than the former. (²) Its comparative weakness, as well as a singular distraction of the senses, in one in whom they were so well trained, made Laennec overlook it; and the mischievous re-action of the mind on the senses perpetuated the error. He says,* "on applying the stethoscope, with its funnel-shaped cavity open, to the chest of a healthy person, we hear, during *inspiration and expiration*, a slight, but distinct murmur, answering to the *entrance* of the air into, and its *expulsion* from, the air cells of the lungs." Thus he describes in the most explicit terms the production of sound during both periods; he remarks that this sound accompanies on the one hand, the entrance, on the other, the expulsion of the air. Any one who has analysed these two sounds, and recognised their perfect independence, will perceive from these words that Laennec's ear had heard both; but his mind had noticed only one, and from that moment, the sense was subjected to the mischievous influence that usually accompanies every preconceived opinion. His attention had slumbered on this point, and was never after awakened. Many other circumstances might have brought him back to the right road—the analogy of the larynx, in which the two sounds had been studied; auscultation at a distance, which in like manner analyses both,—physiology, even physics, and above all, the study of the morbid sounds, where we sometimes meet the expiratory murmur so developed. But no; he had passed on without observing the fact, and it was not for years after, it was not till the death of Laennec, and the kind of enfranchisement which resulted from it, that the error was perceived. A remarkable example of the despotism the mind may obtain over the senses, as well as of the mysterious dominion a man of genius exercises over all that comes within the sphere of his activity! It is curious to observe how M. Meviadec Laennec, obeying, without being aware of it, this influence, has given† this passage of Laennec; he has stripped it of all that belongs peculiarly to the senses, and has left only what belongs to the mind: "the penetration of air into the respiratory apparatus is accompanied with a slight murmur, which is distinctly perceived by means of auscultation, and constitutes what is called the respiratory murmur."

I avow that before placing myself in the position for observation described above, I had often read this passage in Laennec, without meeting any thing that arrested my attention, and that like him, and like all the world, I had heard, or at least perceived but a single sound, that which was called, and is still so generally called, the *respiratory murmur.* I was obliged to separate, by the aid of reflection, and as it were with violence, the operations of the senses from those of the mind, in order to avoid the common error. It was only then that, on a fresh perusal, I comprehended the full force of this passage in Laennec.

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* Auscult. Med. edition d'Andral, 1837; vol. 1, page 60—Forbes' translation of Laennec, 3rd edition, p. 29.

† Andral's edition of Laennec, p. 76.

The Academy of Medicine, February the 27th, 1838, appointed a commission to examine different communications I had laid before it: the commissioners that attended found no difficulty in distinguishing the two *normal* respiratory murmurs, and recognising the different characters of each; this was more especially easy to one of them, M. Andral, as he had himself long since ascertained the truth of the fact, in the patients in his wards, who had served for my researches.

If we proceed to analyse the two sounds of respiration, and compare the result of this analysis with what Laennec has said respecting the *respiratory murmur*, it is evident that the sound to which he gives that name, as well in the normal, as in the morbid state, is the inspiratory murmur, and that it is the murmur of expiration he has overlooked.

We may therefore retain in our new route nearly all that Laennec has written. All is accurate, or nearly all, if we apply it to inspiration; but it is at the same time evident, that the entire half of the domain of auscultation is left uncultivated: perhaps we might even say more than half; for not only has one of the two sounds of respiration been altogether overlooked, but the natural relation between those two sounds, and every thing that depends on the disturbance of that relation, as well as on the disturbance of the expiration, has also been unnoticed. The neglect of these two things has been sometimes even the source of errors, which we shall have to point out. Fortunately, many of the facts, as well particular as general, which Laennec connected with the sound of inspiration, are applicable to that of expiration: hence it is that, without being aware of it, he has in some degree anticipated a part of the history of the fact he overlooked, in the history of the fact he recognised and analysed with so much ability. It will be seen, however, by a glance at this question, and the consequences it involves, that diagnosis must gain much both in extent and in certainty, by the recovery of this omission of Laennec, by the rectification of some errors which have resulted from it, and finally by the completion thus given to his beautiful labours. We may give one or two examples of this:—In neglecting the study of the expiratory sound, he deprived himself of a precious source of diagnosis in the first stage of pulmonary phthisis. He has expressed on this point the following opinion, to which we have now a right to revert. "But when these tumours (tubercles, &c.) are small, * however numerous they may be, if the pulmonary tissue in the intervals between them is healthy, auscultation furnishes no sign." In pulmonary emphysema, the respiratory murmur, says Laennec,* (and it has been repeated after him,†) is much diminished, or even altogether abolished; and yet when we analyse carefully the two sounds of respiration, we find, it is true, that the inspiratory has suffered the changes indicated, but that the expiratory on the contrary has greatly increased, both in extent and in intensity.

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* Auscult, Med. ed. 1837, vol. 2, p. 8.

Physiological accuracy then compels us to admit, that instead of the single sound, to which Laennec has given the name of *respiratory murmur,* there exist two very distinct sounds: one stronger, belonging to the period of inspiration; the other weaker, produced during expiration. On the other hand, pathological observation confirms this division; for we see the weaker sound become at times the stronger, and *vicê versâ;* lastly, the interests of diagnosis require it, for a number of valuable signs result from this mode of studying the sounds of respiration. Hence this auscultatory principle: *always to observe and analyse the inspiratory and expiratory murmurs separately; at the same time that by viewing them together, we appreciate the changes that may have occurred in their natural relation to each other.*

This primary fact of the existence of two murmurs being established, the fact of their morbid modifications being also clearly ascertained, as well as the existence of a number of signs corresponding to these modifications, we must, in order not to lose any of these signs, investigate in the normal murmurs, all the different circumstances from which they may be derived. In this way we will come to multiply the number of signs. Thus then we are led to investigate, in the inspiratory and expiratory murmurs, their proper characters, and their general properties as sounds; to choose amongst these properties, those whose modifications may furnish practical signs; to expound in a methodical order the whole of the morbid characters of these sounds, and to introduce, as far as possible, into those different analyses, the principles and precise language of physics. In this way the science of auscultation will gain both in extent and in precision: in extent, by the appreciation of a greater number of characters, both normal and morbid, and by the application of these characters to two sounds instead of one; in precision, by the more rigorous analysis of these characters, by the greater facility of comprehending the chain of their relations, and the general principles that govern them.

The following are the fundamental characters that it seems to me useful to analyse in the respiratory murmurs:—

1. The proper or distinctive character.
2. The hard or soft character.
3. The dry or humid character.
4. The *quality* (*le timbre*). (3)

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* Ausult, Med. ed. 1837, vol. 1, p. 373—Forbes' Translation, p. 162.

† Memoires de la Soc. Med. d'Observ. Emphy.; Louis, p. 212.

5. The tone.
6. The intensity.
7. The duration.
8. The rhythm.

All the morbid modifications of the respiratory murmurs, that are susceptible of any practical application, may be referred to one of the above sources. For this purpose physiology, pathology, and pathological anatomy at once lend their united aid: physiology, which serves as a type or unit of measure; pathology, which compares with this unit each fact it furnishes; pathological anatomy, which gives value to the differences, by exhibiting the organic states that correspond to them.

A. The *proper character* of the normal respiratory murmurs is a *breathing or blowing* (*un souffle*); the proper character of a certain class of morbid sounds, is also a blowing, but of a different kind; the proper character of the large class of alterations of *quality* (*timbre*),* consists in that sensation which is called *metallic;* the proper character is something *sui generis*, which represents the nature of a phenomenon, or of a group of phenomena, whilst the other characters express rather its forms and different accidents.

B. The *hard character* and the *soft or mellow character* are the opposite of each other: the latter produces on the ear an agreeable impression; it has in it something free, unconstrained, natural; the vesicular expansion of a healthy lung during a normal inspiration furnishes this character in its most perfect form. By a gradual degradation of this soft character, we pass to the hard: this leaves a disagreeable impression on the ear; there is in it something of difficulty, of roughness, of restraint, which gives the idea of an obstacle to motion, of a dense and unyielding tissue, of a rough surface, &c.† The pleuritic friction sound may serve as a type of this character. The first represents the pliant, yielding condition of the tissues, and is a more favourable sign according as it is more complete; the second represents the opposite state, and is always proportional to the obstruction of the functions of the part in which it is produced.

C. The *dry and humid characters* approximate closely to the preceding. The hard character always conveys an impression of dryness; the soft character almost always accompanies the sensation of humidity, but the latter does not always accompany the former. The dry character is but a form or degree of the hard; the humid character, on the contrary, is a distinct type; the dry character is the opposite of this type; like the preceding, they may alternately degenerate into each other. In respect to prognosis, the dry is to the hard character what the humid is to the soft: there exists, however, a very wide difference between the soft and humid characters, for the perfect state of the one represents the physiological condition,‡ while that of the other depends on conditions essentially pathological.[*] The prognosis from the humid character varies besides with the sensation of more or less viscidity: the more marked this sensation is, the more serious are the organic changes with which it corresponds. It is the reverse, when the liquid that determines this sensation leaves an impression of great fluidity.

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* The clear, blowing, bronchial, cavernous, amphoric *quality*, &c.

† First stage of phthisis, emphysema of the lungs, dry pleurisy.

‡ Normal respiratory murmurs.

D. It is not yet known upon what circumstance in the composition of bodies, that property of sound which is called the *quality* (*timbre*) depends. The most general fact we can establish on this subject, in the relations of symptomatology with pathological anatomy, is that in general the alterations of *quality* in the normal murmurs present themselves in cases of augmentation of density of the tissues,[†] and increase of diameter of the tubes traversed by the columns of air.[‡] The ear does not easily mistake this character when it has once heard it distinctly. The impression usually made on it may be conceived by recollecting that typical and common sound, which is called *metallic*. This character presents several degrees: these degrees are connected together by successive gradations, through which each of them passes in its increase, or its decrease; the chain is continuous, regular, from the highest to the lowest degree; and we often see one of the morbid murmurs that compose it, follow it throughout its entire length.[§] Its progressive increase is always an unfavourable sign;[‖] its highest degrees, in general, make their appearance only a short time before death;[¶] its progressive decrease, its return to degrees lower and lower, is on the contrary a good omen; the lowest degrees in this kind of retrogression usually denote the resolution of congestions. Every thing in this phenomenon belongs to pathology; there is nothing physiological that resembles it, unless perhaps, and that in a very remote degree, respiration in the child. Among the different morbid sonorous phenomena, it is one of those that appear latest, one of those, therefore, that indicate organic alterations far advanced;[**] it is, moreover, one of the most unequivocal characters, one whose course is the most regular, and whose laws are the most fixed. It ceases, but it never changes into one of the other types, whereas we have seen that the two preceding characters may be transformed into each other.

E. The *tone* or the *height* of a sound, depends on the number of vibrations in a given time. It is sometimes useful to appreciate the degree of height, or the tone of certain morbid sounds of the respiratory apparatus: the most general physical fact that it is important to keep in mind, in the analysis of this circumstance, is that the acute tone corresponds to the greater number of vibrations, and the grave tone to the smaller number;

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[*] Active sanguineous congestion of the lungs.

[†] Phthisis, pneumonia, pleuritic effusion.

[‡] Dilation of the bronchial tubes.

[§] For example in phthisis.

[‖] Pneumonia, phthisis.

[¶] The cavernous and amphoric characters in phthisis and in hydro-pneumo-thorax.

[**] In pneumonia and phthisis, in comparison with the other characters furnished by auscultation in these diseases.

the anatomical fact that it is necessary to connect with the preceding, is that in general these two degrees in the height of the sound correspond to differences, in an inverse respect, in the diameter of the air tubes: the acute tone to the diminution of these tubes, and the grave tone to their relative augmentation.*

If we compare the two kinds of phenomena we have just noticed, one physical, the other anatomical, we will find a natural connection between them: we know, in fact, that in passing through tubes, a column of air produces vibrations, whose number is directly proportional to the narrowness of the tubes; that the number of vibrations increases, (acute tone) when the air passes from a wider into a narrower part, and diminishes (grave tone) in the opposite case. The sonorous phenomena of this class are in general transitory, fugitive, of moderate value; they may depend on lesions, purely nervous, as well as on physical conditions, and the latter are sometimes very serious, sometimes very slight: they appear much oftener in diseases of the larynx than in those of the lungs. In this work, I will only take them into account in the study of the bronchial ronchi, and of the characters that the voice and cough supply in the diagnosis of the first stage of phthisis.

F. While the height of a sound depends on the number of vibrations, its *intensity* depends on their size; but here, without confining ourselves to the precise physical definition of the word, we will understand by intensity what is commonly understood, the distance to which the sound is propagated, and the degree of force with which it strikes the ear.

G. By the *duration* of a sound, we understand the time during which the perception of the sound is prolonged. The duration and intensity of the murmurs are sometimes intimately connected with one another;† sometimes they separate and are modified in different degrees, or even in opposite directions. ‡ It is much more easy to connect anatomical circumstances with the intensity than with the duration: the first is referable to two different kinds of cause; it is sometimes the result of changes in the organ itself in which the sound originates, § sometimes of changes in the neighbouring organs; ‖ in the latter case it depends solely on the conditions of conductibility that surround the organ in which the sound is generated; we may say, in general, that its increase is directly proportional to the density of the tissues, and its diminution to their rarefaction: with respect to the duration, it usually depends on causes much less easily analysed, the degree of elasticity and contractility of the tissues appearing to influence it in certain cases.* However, though its causes are more doubtful, the character of duration is not less precious than that of intensity; the diagnosis in general derives most advantage from analyzing them in their relations with each other; in fact the laws that govern them are tolerably constant, and hence the changes that occur in the one, assist us in appreciating the value of those exhibited in the other; both have, besides, the following advantages:—they are usually the first to appear of all those signs we have described, and thus give us information in the earliest periods of disease; † they may, though appearing at the commencement, persist a very long time, and come to indicate a considerable change in the primary conditions of the organ; ‡ the series formed by them is very extensive, as successive and as regular as that of the alterations of quality, and capable of being followed and appreciated with equal ease. These two characters are never confounded, are never transformed, and though frequently connected, remain always perfectly independent of each other.

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* The first of these two propositions is however, much more true and more general than the second; at times both the acute and grave tones are heard at the same time in the same lung; in general, in this case, the only anatomical circumstance we observe is that which we have considered as belonging to the acute tone: it may indeed be said, that in this case, the anatomical condition of the grave tone is represented by the relative dilatation of the healthy bronchial tubes.

† Pneumonia, pulmonary congestions, pleuritic effusions.

‡ Phthisis in its first stage, pulmonary emphysema.

§ Pneumonia, pleurisy, emphysema, phthisis.

‖ For example: the imperfect transmission of the voice and sounds of the heart in cases of considerable emphysema.

H. The word *rhythm* has several meanings; sometimes it signifies the order in which several independent, but accidentally combined phenomena follow one another (this is its largest and least used signification); sometimes it expresses the order of succession of several phenomena connected together by intimate relations, concurring to the same end, and constituting the same fact, as, for instance, the rhythm of the two respiratory sounds; lastly, the application of this word is sometimes still more restricted, and it is employed to designate the different periods, the different parts of the same phenomena, and the mode in which the succession of these periods and parts is accomplished. This is the sense in which we shall use it when we say, the rhythm of such a sound in particular. The second acceptation is almost the only one that admits of any useful applications, and in this point of view, the consideration of the rhythm forms some part in the appreciation of the relations between the inspiratory and expiratory murmurs. The study of the rhythm is of little use in diagnosis; it is, however, sometimes useful, especially for comprehending the connection between the phenomena, and aiding us in the investigation of the laws that govern them.

All these different characters may be combined with each other in a thousand ways, and the diagnosis may be most materially aided by the analysis of these combinations. Many of them obscure at first sight, and apparently confused, are governed by fixed principles, and these principles are in some cases more fixed than those that are connected with the existence of the sound itself. There is usually an intimate relation between certain combinations of phenomena and certain physical circumstances; but we are not always able to discover this relation. Sometimes, in a given space of time, different combinations succeed one another; in some cases it is also possible to find a regular chain of connexion in this succession of changes, and to discover the reason of this connexion. Phthisis pulmonalis, followed step by step in its whole course, in all the different accidents that by turns affect the lungs, is one of the diseases in which we observe the greatest number of those combinations, and in which it is most easy to discover the law that governs them; to such a degree, that it is possible, as we shall see hereafter, to exhibit these different combinations, either separately or in succession, in the form of so many problems, of which experience furnishes the solution.

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* For example: the expiratory murmur prolonged in emphysema of the lungs.

† Pneumonia, pleurisy, phthisis, &c.

‡ Phthisis, emphysema.

In general, we may say—1st. that the alterations of *quality* in their lowest degrees are most frequently combined with most of the other characters; but that they obscure and efface those characters in proportion as they become more marked,* and that then they tend more and more to exist alone; 2nd. that the character of hardness is frequently combined with the character of duration;† 3rd. that the character of rhythm is almost inseparable from that of duration or intensity;‡ 4th. that the two latter, almost constantly found united, coincide frequently with the character of humidity, especially when this character exists in its highest degrees, for example, in the bubbling form.§

Custom has consecrated the use of the term *murmur* (*bruit*), instead of *sound*, to designate the acoustick phenomena of the different systems of the economy; and though it is most frequently inaccurate, as regards the physical definition of the word, there is an advantage in preserving it, because the common acceptation is well defined.

Of the dry, humid, and bubbling characters.

In reference to the dry and humid characters, I think it right to give a summary of some experiments, which will enable us to comprehend better the nature of these characters, and their possible applications to diagnosis, by explaining their mode of production.

A. If a perfectly dry sponge be subjected to an alternate movement of compression and dilatation close to the ear, we hear a very distinct sound, slender if the sponge be fine, and of more volume, of it be of coarse texture; and this sound, the result of the compression of the tissue of the sponge and its expansion by the air, gives a very distinct sensation of dryness.

B. If the sponge be moistened, we get with this sound a sensation of humidity; and this character becomes more and more marked, in proportion as the sponge contains a greater quantity of liquid. When this passes a certain limit, when it is in such quantity that each little column of air that penetrates into the cells of the sponge can expand, and form a little bubble, such as is formed by blowing with a tube into any kind of liquid, then the sensation changes.

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* Pneumonia, pleurisy with effusion, phthisis.

† Pulmonary emphysema, phthisis.

‡ Pulmonary emphysema, phthisis.

§ Serous and sanguineous congestions of the lungs, pulmonary catarrh.

C. If this change in the sponge, from a dry to a humid state, be conducted by insensible gradations, we perceive the humid character increase, remain for a time homogeneous, and then divide into a number of small unequal consecutive sounds; these afterwards become more marked, separate a little from each other, assume each a rounded form, and at length produce the sensation of bubbles originating, being developed, and bursting; at this point, the humid character deserves the name of *bubbling;* but it always leaves on the ear its primary impression of humidity.

We can easily vary the results, by varying the fineness or coarseness of the sponge, its degree of expansion, the conditions of its tissue as to texture and motion, and the nature of the fluid with which it is moistened. I have, in this way, by producing in the sponge a certain number of the anatomico-pathological conditions of the lungs, succeeded in obtaining artificially several of the physical signs furnished by these organs. I confine myself to a description of some effects which have a more direct connexion with some symptoms I shall have to describe.

1st. The character of dryness and hardness in the sound produced by the alternate compression and expansion of a dry sponge, may have different degrees; these degrees vary according as the sponge is more or less fine or pliable, and free from all admixture with foreign bodies, or as it is hard, stiff, coarse, and contains the little shells we sometimes find scattered through it. These different forms, these different degrees of dryness and hardness, may be compared to the same characters presented sometimes by the respiratory murmurs; for example, to the character of dryness in cases of severe emphysema, or rather to the hard, rough, crumpling character we meet in the first stage of phthisis; or still more to the crumpling sound, to the dry crackling ronchus which is in like manner produced in the same disease at the same period.

2nd. If the sponge be moistened with water simply, the impression of humidity felt resembles the sensation produced by the respiration of an œdematous lung. It seems as if the ear perceived that the liquid, with which the sponge is moistened, is devoid of consistence and viscidity.

3rd. In fact, if the sponge is soaked in blood, or in a slightly sirupy or gummy liquid, the ear at once feels that the dilatation of the sponge no longer takes place in the same way; it feels distinctly the impression of something viscid, fatty, glutinous; and this impression resembles the sensation produced by the auscultation of a lung in a state of *active sanguineous congestion*, (see first part, ch. 17, sect. 2, 5, 3). This character of the respiration accompanies hæmoptysis.

4th. If the sponge be fully saturated with this gummy solution, or with blood, then the bubbling character appears, but with particular shades: the walls of these bubbles seem to be thick, and not easily broken; their developement, their spherical form is attained with a kind of difficulty; it is always very incomplete, unless the tissue of the sponge is gorged with fluid, and that its cells are rather large. According as the bubbles are more or less voluminous, more or less confounded with each other, they give the idea of that peculiar ronchus I shall hereafter describe under the name of *humid ronchus with continuous bubbles*, which forms one of the signs of active sanguineous pulmonary congestion; or they resemble perfectly the large mucous ronchus, which is heard in the large branches of the bronchi and in the trachea, at the period of mucous secretion in acute pulmonary catarrh, or a little after an attack of hæmoptysis.

5th. If we take a fine sponge moderately moistened with water alone, compress it in a point, and then withdrawing the finger, allow it to be expanded by the air, crepitation is immediately produced. This crepitation is regular and rapid, close, equal, very round and fine; in short, it is precisely similar to one of these puffs of crepitant ronchus, heard in pneumonia, especially during the inspiratory movement. If the finger be withdrawn gradually, this crepitation is prolonged, and then resembles these long puffs of crepitant ronchus, which we hear when the patient makes a deep and regular inspiration. It is short, and the bubbles few, if the finger be withdrwn suddenly; in this case also the bubbles are imperfect, as is sometimes the crepitant ronchus in a short, rapid, semiconvulsive inspiration. If the finger be raised little by little, and that the air penetrates with difficulty, and as it were by small successive efforts, into the humid cells of the sponge, the bubbling character is imperfect; or there are merely some scattered bubbles which crepitate at intervals; thus it is that in pneumonia, occupying the entire mass of one lobe of a lung, when only some cells here and there remain pervious to air, with whatever attention we listen, we hear merely some scattered bubbles, in general incomplete, widely separated from each other, and leaving the impression of an effort made for their developement; very different in this respect from the large puffs of crepitant ronchus, which convey the idea of a rapid and ready penetration of air into the pulmonary tissue; it is moreover distinctly felt, that this penetration takas place over a much larger surface. It is for this reason, that in the course of a pneumonia, we ought in general regard as a serious indication these scattered, rare, imperfectly and difficultly developed bubbles; and on the contrary, think better of the physical condition of the lung, when we have these large puffs of crepitant ronchus reproduced at each inspiration. In the former case, the bubbles frequently do not appear till the second or third inspiration, and are not developed till towards its termination. The crepitant ronchus presents this peculiar character of infrequency and separation of its bubbles, when the pneumonia is passing from the first to the second stage, or at the period of its return from the second to the first. It is obvious indeed, that in both these cases, as well as in considerable engorgement of the entire mass of a lobe, there are only some cells here and there pervious; whereas, at a period less advanced, and in a more diffused engorgement, a much greater number of cells may admit air, and be more completely expanded. Such is the physical cause of these differences. When at a late period the crepitant ronchus diminishes and disappears, this depends on another cause, the diminution and cessation of one of the elements of production of ronchi, the presence of fluid in the bronchial ramifications. As much of the sponge as can be covered and compressed by the top of the finger, or even less, is sufficient to produce a crepitation as long and as complete as the largest puff of the crepitant ronchus. If we submit the entire sponge to this sudden penetration of air into its moistened cells, the puff of ronchus resulting does not produce a much louder sound than that produced by the crepitation of the small portion spoken of above; but its crepitation is more prolonged, the sound somewhat more distinct, its *quality* clearer. There is not then a distinct ratio between the sound produced and the number of bubbles that crepitate, between the sensation of a stronger or feebler sound, left on the ear by the crepitant ronchus, and the number of pulmonary cells and lobules that remain pervious: the one cannot therefore enable us to judge absolutely of the other; but we may sometimes with a practised ear, and by means of the differences, I have pointed out in each of the two cases of the last experiment, probably arrive at notions of some use in diagnosis. For this purpose we must keep in view the two causes that concur in the production of the phenomenon: 1st. the degree of motion with which the air enters; 2nd. the physical conditions of the tissue it penetrates. If either of these elements be neglected, the solution of the problem will be inexact.

6th. The experiments with sponge may serve another purpose. If we take a sponge half a foot long, and place the ear at one end of it, and produce at the other the puffs of crepitation I have been describing, the sound, however strong it be, will scarcely reach the other ear; beyond this point it is totally inaudible; on the contrary, it becomes more and more distinct in proportion as the ear is brought nearer the point in which it is produced. If the portion of sponge between this point and the ear be completely soaked in liquid, the crepitation reaches the ear more readily than if the sponge be squeezed dry. But in either mode, the sound is propagated worse than when no foreign body whatever is interposed between the sponge and the ear, in which case the crepitation is heard at the distance of a foot. The crepitation is no longer audible, if the interposed body is any soft substance; it is only diminished, if we use, as a conductor, a solid body such as a piece of wood. If we make a small moist portion of sponge crepitate at some inches from the ear, at the same time that we make an intermediate dry portion contract and dilate alternately, the slight murmur produced in the latter prevents us from hearing the former; the one is the image of respiration in the outer layer of a lung, the other represents the crepitant ronchus that most probably exists, but is sometimes inaudible in central pneumonia. By applying to the case of a diseased lung what we have said of the sponge, we will see the reason of several phenomena, or of several circumstances of phenomena, which we could not well explain without the aid of experiments. The crepitating sound of the sponge is propagated to a greater distance, in proportion as the bubbles are more voluminous, and more complete in their developement, because they then produce a louder noise in bursting. It is the same of the different ronchi that are produced in the different sections of the bronchial system; those that arise in the small ramifications, and whose bubbles are fine, slender, &c. are propagated a much less distance through the pulmonary tissue, than those that are produced in the higher sections of the respiratory canals. The conditions of conductibility of which I have spoken above, are in like manner very applicable to the different shades of alteration which may be found united in the same lung; at the same time that they complicate the problem, they may assist in solving it, or at least they may afford an explanation of some facts that seem irregular; for instance, we can very easily, from these experiments, explain why the crepitant ronchus is sometimes wanting in central pneumonia; now this fact, which they would have led us to anticipate, has been established by clinical observation. M. M. Andral,* Chomel,† &c. have pointed out the error of Laennec in this respect.

7th. If we listen to the crepitation produced in one portion of the sponge, and conveyed through another portion moistened and placed nearer to the ear, we get a very distinct idea of the character of remoteness which any sonorous phenomenon may present. The ear feels distinctly that the sound is produced at a distance; and knowing the mode of propagation of these sounds through the tissues, it can even appreciate that distance. It feels equally well when the phenomenon is produced immediately beneath it. If two different sounds are produced at a distance from each other, so that both are audible, it distinguishes them quite well, and determines with certainty which is the deep, which the superficial sound. Such is the case when we produce in the part of the sponge nearest the ear that slight murmur caused by the entrance of the air into its dry and yielding tissue, while we excite in a part more remote and moistened with water, the crepitation I have described; this is the phenomenon presented by a lung whose superficial layer is sound, while the parts below have become the site of a peripneumonic engorgement.

8th. In its movement of expansion, the tissue of the sponge produces a sound which resembles that of inspiration. No very distinct sound is produced by its compression. This sound resembles the inspiratory, especially in this respect, that in it also the impression made on the ear is of the penetration of air into an infinite number of little cells which are dilated by its pressure. The duration of this sound is directly proportional to the thickness of the part of the sponge compressed, that is, to the number of cells expanded by the entrance of the air ; it is also directly proportional to the slowness with which the air penetrates. Its intensity follows nearly the same law, but in a less obvious manner. The inspiratory murmur is apparently produced by the same mechanism, and obeys the same law ; that is, that in the healthy state and the ordinary conditions of movement, its duration and intensity being determined by the mass of the organ, and this mass remaining the same, these two characters will also always be the same. This it is that enables us to represent by numbers (see hereafter) these two qualities of the inspiratory and expiratory murmurs ; this it is that gives value to that method. Thus in the normal state and in the ordinary conditions of movement, the duration and intensity of the two respiratory murmurs have natural limits which, like the physical fact that determines them, are constant. I have supposed that the conditions of movement remain the same ; it is obvious, indeed, that if the movement by which the air enters or quits the pulmonary cells be increased or diminished, the sound will rise above or fall below its normal limits. Hence, in order to have an accurate idea of the phenomena I am describing, it is necessary to place the patient in his ordinary conditions of respiration. In this explanation we have the key of all the changes that can occur, in the intensity and duration of the respiratory murmurs. All these changes, of whatever kind they be, increase or diminution, depend on two causes :—1st. different conditions of movement ; 2nd. different conditions in the mass of the organ, that is, in the number of cells pervious to air. Sometimes these causes act separately, most frequently they are united. The changes in the intensity and duration of the sounds, which depend solely on a modification of movement, are in general neither very serious nor very durable, because this generally results merely from nervous influence. They are much more serious when they arise from a modification in the mass of the organ. The conditions of movement, however morbid they be, remain nearly the same as long as the physical lesion of the organ exists, or continue to bear the same ratio to it ; hence the duration and intensity of the respiratory sounds follow the same law of increase and decrease as this physical lesion ; hence these sounds express by their degree the progress and degree of anatomical change ; they remain stationary with it ; they increase and decrease with it. Thus we are enabled to extend to pathology the method of expressing by numbers the duration and intensity of the respiratory murmurs. In this consists the object and advantage of this method ; a murmur being given, we express by a number the normal conditions of its intensity and duration ; this number is 10 for the inspiratory, and 2 for the expiratory murmur. We have here two fixed points, above and below which we construct a graduated scale, which descends to 0 and rises to 20. Between the two extremes we have all the degrees comprised between 0 and 20. The conditions of the intensity and duration of the murmurs change; these characters rise above or fall below their normal number, and, both above and below, their changes are expressed by successive degrees, which themselves express more accurately than any words, the physical conditions of the organ. If, after the compression of the sponge, we only allow the air to penetrate its tissue imperfectly, the sound which is produced and which we have compared to that of inspiration, is diminished exactly in proportion to the resistance we make to the dilatation of the cells of the sponge. This diminution affects at once both the intensity and duration, and is the image of the changes that the intensity and duration of the inspiratory murmur suffer in this respect; it reveals the general physical fact upon which these changes depend, the diminution of the mass of the lung, that is, of the number of cells pervious to air, or merely the diminution of that perviousness. The experiments with sponge teach us nothing as to the changes that may take place in the duration and intensity of the expiratory murmur; but they enable us to see how the augmentation of the duration and intensity of the inspiratory is produced. The mass of the sponge is represented by 2; the greatest possible quantity of movement, that is of expansion of its cells, by 2 also; in the ordinary motion to which I submit it, I avail myself of each of those conditions but as 1; there remain therefore 2 in reserve, and if I wish to avail myself of all my resources, the sound produced will be as 4 instead of being as 2; for I have already shown that the intensity and duration of the sound of the sponge, are directly proportional to the number and expansion of its cells. Now the sponge is here, as before, the image of the lung; in availing myself of the means at my disposal but as 2, I produce the ordinary inspiratory murmur; in availing myself of them as 3 or 4, I produce puerile respiration.

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* Auscult. Med. ed. d'Andral, v. 1, p. 530—533.

† Dict. de Med. en 21 vol. t. 17, p. 227.

The different physiological and pathological conditions of the lung may in fact be tolerably well represented by the sponge suitably adjusted. Like the lung, it has its movement of inspiration and expiration; the one represented by its compression, the other by its elastic expansion; by the expulsion from, and the penetration of air into its cells. The lung, like the sponge, has its conditions of dryness,* and of humidity;† the liquids that produce in it the humid character, are very fluid in some cases,‡ very viscid in others.§ There is therefore nothing strange in the tolerably perfect similitude of the effects produced in each. I have confined myself to some useful comparisons between the sonorous phenomena of the sponge, and those of the lung, but it is easy for any one to increase the number. Thus if, in the preceding experiments, we employ a fine sponge, we find that the crepitation is confined exclusively to the period that we may call the inspiration of the sponge; if we employ a sponge the cells of which are large, there is a little crepitation produced during the movement of compression or of expiration also; in the latter case, the crepitation is coarser and more humid. What do we see in this experiment? small cells producing a fine crepitation, which is audible only in inspiration; and large cells, in which a coarse crepitation is produced, which is heard during inspiration particularly, but also during expiration. Now we have here the double image of the bubbling vesicular ronchi, and of the bubbling bronchial ronchi, (see 1st part, chap. iv). The first are only produced during inspiration, the second accompany this, but also coexist with expiration, (laws of co-existence, 1st part, chap. v). The analogy therefore between the phenomena of the sponge, and those of the lungs, is perfectly natural. The causes being the same, or nearly the same, the effects ought to be similar. If the comparison holds good during almost the entire duration of a phenomenon or a group of phenomena, this depends on the permanence of the causes that produce them. For the same reason, the peculiar impressions made on the ear have the same value as all physical phenomena; that is, that, in general, they are constant; that in the same circumstances they occur in the same manner; and that therefore they may be justly regarded as representatives of these circumstances.

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* Pulmonary emphysema, 1st. stage of phthisis.

† Serous or sanguineous congestion.

‡ Œdema of the lung.

§ Active sanguineous congestion, mucous secretion in the bronchi.

M. M. Piorry, Beau and Leclaire have made experiments, which are analogous to those I have just detailed; they are reported in the Traite de Diagnosis, vol. 1, page 467, under the nos. 6, 7, 8, 9, 10. Having injected water into the lungs of a calf, and then blown air into the trachea, they found that mucous and sibilant ronchi were produced, when the quantity of water was small; fine ronchi, extremely humid, when the quantity was greater. They ascertained that the latter were produced in the tissue of the lung itself, and not in the bronchi. On pressing, close to the ear, the pulmonary tissue moistened with water, and allowing it to be afterwards expanded by the entrance of air, as I did with the sponge, they heard the same crepitation I heard in the latter. This is in some degree the counterpart of the experiments I have just described, and confirms some general conclusions which result from them. Mr. Spittal of Edinburgh* has also made some experiments, the results of which bear upon this subject. Having put liquids of different densities into several vessels, he produced by agitation bubbles of air at the surface of each, and comparing the small crepitation produced by the rupture of these bubbles with the crepitant ronchus, he remarked that the serous liquids, and such as resemble them in density and viscidity, were those in which this phenomenon was most readily produced. These are the only conclusions attributed to him by the editor of the Archives. (4)

5. A science almost always has two epochs: the first, of particular facts; the second, of general facts. In the hands of Laennec, and of

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* Archives Generales de *Medicine*, tome 29, année 1832, p. 289.

those who followed close upon him, auscultation passed over both nearly at the same time, and the second almost as completely as the first; such was the energy and acuteness, such the sagacity and accuracy of mind they brought to bear upon it; such the rapidity with which facts are generalized, and their relations discovered, when they are of a kind easily observed, and always subject to the same laws! However, it appeared to me possible to reduce the abundant materials of auscultation to greater simplicity: many of the phenomena which are regarded as independent of each other, appeared to me to belong to the same type of which they were but different forms or degrees; a considerable number of particular facts seemed to be included in some general ones, much more satisfactory to the mind, and more convenient to the memory. I thought it might in this way attain more precision as a science, more utility as an art, and I have attempted it. He that knows the general principles that govern the particular facts, is much more advanced than he that knows only the latter, however well he may know them; the one precedes the event, the other can only follow it. But here more than anywhere else prudence is necessary. Nor do I mean to offer the generalizations contained in this work, as any thing more than so many propositions that experience has hitherto appeared to sanction.

4. The murmur of inspiration and that of expiration marking each a separate period in the complete movement of respiration, the different morbid sounds may present themselves with the one or the other only, or with the two together; and as the causes on which this co-existence depends, are usually physical causes, fixed causes, it follows that the co-existence of the morbid sounds with such or such a period of respiration, may, in many cases, furnish useful diagnostic signs, because we are in this way enabled to ascend from the effect to the cause. Not that it is always possible to establish this relation upon physical principles, and to explain why the fact is so; but of what importance is this in practice, provided the fact be well established, provided we have ascertained a constant, or nearly constant connexion between such a mode of co-existence of a morbid sound, and such an organic alteration? I have applied this means of analysis to all the morbid sonorous phenomena that appeared to me susceptible of it.

5. One of our good modern works * says: "We have no signs capable of clearly indicating, in cases not far removed from the healthy state, whether the lung has suffered some commencement of change, or whether its functions are performed with regularity." Such is, in some degree, the reply of auscultation to the sage counsel of antiquity: "*Principiis obsta.*" Long impressed with the importance of this principle, I had taken it as a guide in my clinical studies, and especially in my researches on auscultation. The great delicacy of sense required to recognize the

* Compendium de Medicine Pratique de M. M. Delaberge et Monneret, tome 1, 464.

symptoms at their first appearance; the danger of confounding them with passing modifications of healthy actions; the difficulty of determining among the shades that distinguish them, those that are sufficiently permanent to have a certain value as signs; the sagacity requisite to discover the real relation between the first symptomatic manifestations, and the first changes that take place in the tissue of the organ, all concur to retard very much this part of medicine, and all warn us to employ the greatest rigour in researches of this nature. The disease that most loudly called for the application of this principle, and of these researches, was undoubtedly phthisis pulmonalis. We cannot reasonably hope to do any thing for those afflicted with it, except by applying, to the first stage of the disease, the hygienic or therapeutic resources which medicine supplies. I have devoted myself to the study of this first stage, especially as regards its diagnosis; the applications, already rather numerous, that I have been able to make of my researches, induce me to hope that advantage will be derived from them in practice. It was the same principle that guided me in my researches on the signs of active sanguineous congestion of the lungs.

Such, in short, is the course I have followed in the study of auscultation. After having passed some years in these clinical pursuits, without being turned from them for a moment by the study of books; after having attained at least a part of my object, I looked round, and I had reason to congratulate myself on the route I had taken, when I saw that several men of acknowledged ability had likewise adopted it.

A distinguished observer, M. Jackson, was the first to mention the expiratory murmur.* All he has said of it refers to its morbid state, and is extremely accurate. He has even made known some of the general facts that belong to the history of this murmur; thus, its co-existence in phthisis, with diminution of the smoothness and softness of the murmur of inspiration; its appearance in all cases where there is an augmentation of density of the pulmonary tissue; thus also, the successive passage of the bronchial character from expiration to inspiration. When the Memoires de la Societe d'Observation appeared, I was happy to find in previous observations, of which I was ignorant, results so similar to those furnished by my own. There is, however, in the researches of M. Jackson † one result that I cannot admit. He thinks we can distinguish in all cases vesicular from bronchial respiration, by means of the prolongation of the expiration, which occurs, he says, in the latter only. It will be seen, in the course of this work, that the respiration called *puerile* is essentially characterised by presenting a much stronger expiratory murmur than ordinary respiration, and that consequently this character of prolongation of the expiratory murmur is not sufficient to distinguish exalted vesicular respiration from bronchial respiration. It is in the different *quality* of these sounds that their distinctive characters are chiefly to be found.

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* Memoires de la Societe Medicale d'Observation, tome 1, p. 14.

† Ibid. p. 15.

M. Andral was one of the first that recognized the existence of the expiratory murmur in the first stage of phthisis. Observe how he expresses himself on this subject in the 3rd edition of his Clinique Medicale*: "At the same time, that the presence of a certain number of tubercles in a part of the lung, diminishes in this place the sound of pulmonary expansion, another phenomenon may be produced: this is, a stronger murmur than usual, during the period of expiration. The latter, which in general produces no sound, is in this case accompanied by a much more strongly marked murmur, than that which coincides with the movement of inspiration; it is easy to see why this is so."

It is curious to follow step by step the gradations that were passed over in arriving at a knowledge of the expiratory murmur: its existence was recognised in pathology before it was suspected in physiology †; this was natural enough, since it is much more developed, and hence much more appreciable, in the former than in the latter. It was first taken for one of those morbid sounds, of which there is no trace in the normal state, or it was supposed to result from the decomposition of the single murmur admitted in respiration‡. As it had been heard for the first time in the commencement of phthisis, it was regarded as a sign peculiar to that disease§; whereas we shall see that it is common to several different morbid states. At first it was not observed, except when greatly developed‖; afterward it was traced in its inferior degrees, and then came the question, whether it might not be an exaggeration of a murmur, which was peculiar to one of the periods of respiration. From that moment, it was recognised that what had been hitherto called the *respiratory murmur*, was produced during inspiration, and an analogous murmur was sought for in expiration. Sometimes it was perceived; at other times it was supposed to be inaudible¶. At first it was considered an exception, then it was said to be often heard; still later it was admitted, that in the normal state there was an expiratory murmur, *but varia-*

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* Clinique medicale, 3rd edition, v. 4, p. 69.

† Clinique Med. d'Andral, 3rd ed. v. 4. p. 69. Passage already cited.

‡ "The respiratory murmur is decomposed into two murmurs." Note at page 196 of the 2nd vol. of the edition of 1837 de l'Auscultation de Laennec.

§ "The expiratory murmur indicates the existence of tubercles already rather large, and which have obliterated several bronchial tubes," note at page 197 of 2nd vol. of the edition of 1837 of Laennec.

‖ "This (expiration) which ordinarily produces no sound, is then accompanied by a *murmur much more strongly marked* than that which coincides with the movement of inspiration," Clin. Med. vol. 4, page 69.

¶ "When we apply the ear to the chest of a healthy person, we hear, especially during inspiration, a light but very distinct murmur, which indicates the penetration of air into the pulmonary tissue, and which at times marks its expulsion," Compendium de Medicine Pratique, vol. 1. p. 468, see also p. 470.

ble in its intensity [*]; because the limits of the normal state were not well established. We shall see, in fact, that in the normal state, the murmur of expiration obeys as fixed laws as that of inspiration. Some physiological varieties, or some unnoticed pathological states could alone have led to this admission of the variability of the expiratory murmur. Persons, as it were, hesitated before pronouncing positively[†]. But at present, M. Andral, M. Louis[‡], &c. recognize the existence of the two murmurs in respiration; each constant, and having a fixed character; the one stronger, belonging to inspiration, the other much more feeble, belonging to expiration. M. Piorry in his work on Diagnosis[§], sanctions the principle of the auscultation of respiration in its two separate periods. He marks carefully the greater intensity of the inspiratory sound, indicating at the same time clearly, that the expiratory sound is easily appreciable in the normal state. This result, however, has only been arrived at within a very short time, and there are still excellent observers, authors of recent and highly esteemed works on auscultation, who seem not to be aware of the existence of the expiratory murmur, either in the diseased or the healthy state. Such, for example, is M. Histz of Strasburg, who throughout his excellent thesis[‖], never uses any expression but ***respiratory murmur.*** Such is also Dr. James Clarke in his work on Consumption[¶]. The authors of the Compendium de Medicine Pratique (Art. Auscultation) are nearly in the same position. M. Piorry, who carefully points out the principle of the study of respiration in its two separate periods, and who even adds that, in the morbid state, these two murmurs are modified in various ways [**], never suggests in the course of his work any serious application of this principle. In conclusion, the murmur of expiration has been heard and analysed, as well in the normal as in the morbid state, by several observers, but at first timidly, with doubt, with restrictions; for men dared not trust their ears, where Laennec had heard nothing. Besides, those who had been the contemporaries of Laennec, and shared his labours, as well as his opinions, could not believe they had formerly overlooked a sound they heard now; urged at once by the past and by the present, they took a middle course; hence the variability admitted in the expiratory murmur. It was necessary to escape from the past, and place both the senses and the mind in a state of independence, in order to be prepared to call seriously in question the existence of the single respiratory murmur admitted by Laennec, and to see that there existed two. (5) Other observers appear to have seen the necessity of analyzing, in the normal murmur of respiration, a greater number of properties than Laennec did, in order to increase the number of signs resulting from their modifications: but the impression was vague, and remained almost entirely unapplied. Thus we read in the Compendium de Medicine Pratique *: "the respiratory murmur may present modifications, as well in its intensity, as in its *quality*." The same expressions occur in the Clinique of M. Andral, and in some other works.

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[*] "In the study of vesicular respiration, there are then two murmurs to be investigated, *which are more or less marked, according to circumstances.* That which is first heard is the murmur of inspiration, and that which succeeds it, the murmur of expiration," note, page 71 of the 1st vol. of the edition of 1837 of Laennec.

[†] "In the normal state, the respiratory murmur is audible almost exclusively at the time the air penetrates the pulmonary cells; when it issues from them, the sound is much more feeble, and even most frequently quite imperceptible." Note, page 71, 1st. vol. of edition of 1837 of Laennec.

[‡] Clinique de l'Hospital de la Pitie, de 1836. M. Louis taught at this period that the expiratory murmur was extremely feeble and scarcely recognizable, but constant.

[§] Traite de Diagnostic, vol. 1, p. 455.

[‖] Recherches Cliniques sur quelques points du diagnostic de la phthisie pulmonaire, aout 1836.

[¶] Traite sur la Consomption Pulmonaire, traduit par Lebeau.

[**] Traite de Diagnostic, tome 1, page 455.

A greater number of observers have felt the importance of investigating the principles that regulate the coexistence of the morbid sounds with the period of inspiration, or of expiration, or with both at the same time; but this study has been directed almost exclusively to the ronchi, and always in an imperfect manner. We find some traces of the application of this principle in several modern works; but no one has developed it so fully as M. Andral, who considers in this way the crepitant, subcrepitant, sibilant, snoring, and mucous ronchi.

Laennec has given, at considerable length, precepts for the practice of auscultation. There are, however, some which he has omitted, and others on which he has not, perhaps, bestowed all the attention they deserve; I would instance the following:

1. When auscultation is properly performed, the series of acts of which it consists is divisable into two very distinct parts: the operations of the senses, and those of the mind; the first collect the different elements that concur to the solution of the problem, the second judges them. These two kinds of operations ought to be performed at two distinct times, and those of the senses always before those of the mind. This is the natural order. It would perhaps seem surprising, that I should insist on a thing so simple, if it were not well known that more than one observer forms his opinion of the disease before he has practised auscultation, and thus interprets a part of the symptoms before he has collected them; hence arise many more errors than might be supposed.

2. It is of the greatest importance that the faculty of *attention* be excited previously to each act of the senses, or of the mind. We are thus assured from the first of the accuracy of their operations. The opposite state, *distraction*, in abandoning them to themselves or to foreign impressions,

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* Vol. 1, p. 479.

is the source of many mistakes. We are astonished at the difference, when we come to compare together the results of a first examination made with *distraction*, and those of a second made with *attention*.

3. The sense of hearing being once well trained, we can, with the aid of this faculty of attention, during all the time an auscultatory examination lasts, be perfectly insensible to any other sensations than those made on the ear; and then concentrate the attention of the ear upon the sounds produced in the interior of the chest to such a degree, that the different other sounds occurring about the patient no longer affect it. In short, we may be able to concentrate the whole attention of the sense of hearing on a particular sound, without being in any way disturbed or distracted by those that occur at the same time: as, for example, on the augmentation of the intensity of the expiratory murmur, or the diminution of the duration of the inspiratory, in the midst of the other morbid sounds that accompany these in the first stage of phthisis. This faculty is extremely precious; it is only by its aid we can recognize certain delicate shades of alteration in the normal sounds, and estimate their diagnostic value. We can thus analyze one by one several sounds that are produced at the same moment.

4. The physician who practises auscultation must know well, both the physiological varieties that different circumstances produce in the normal sounds, and the proper and distinctive character of all the morbid sounds. Without this double knowledge he is often liable to confound one with the other, and to form false opinions. Hence it is that we cannot derive from auscultation all the advantages it is capable of affording, till we have practised it a very long time.

5. It sometimes happens that in examining the posterior part of the chest, we pass the inferior boundary of this cavity, that we apply the ear a little too low down, and conclude from auscultation that respiration is inaudible at the lower part; hence the diagnosis of a commencing pleuritic effusion. I have often seen persons make this mistake in the wards of an hospital. It is, besides, favoured by the less extent vertically of the respiratory sounds on the right than on the left side; because many, from inattention, forget that this difference between the two sides depends on the presence of the liver.

6. Before applying the ear to the patient's chest, it is well to observe how he respires. Sometimes, in fact, we hear no trace of the respiratory murmurs, or perhaps of the expiratory only, and this depends altogether on the way in which respiration is performed: the patient thinks that we expect something extraordinary from him; he makes convulsive efforts with the muscles of the walls of the chest or of the mouth, and the air either does not reach the lungs at all, or reaches them at intervals, and in an irregular manner. With respect to the isolated absence of the expiratory murmur, it cannot occasion any error if we keep in mind this general fact, that *except in the above circumstance, the expiration is neve*

absent alone, and that this circumstance does not correspond to any anatomical lesion.

7. But it is of importance also, for another reason, to observe how the patient breathes, before we commence our examination; in fact, every kind of respiration is not equally fitted to reveal anormal murmurs; in general we will place ourselves in the most favourable condition in this respect, by taking care that the inspirations and expirations of the patient are frequent, regular, and deep; it is even necessary sometimes when the sounds heard are doubtful, to explain these points to him, or, what is still better, to give him an example by making some respirations before him.

8. The stern air, the abrupt address, the solemnity with which some physicians approach the sick bed, seldom fail to throw the patient into a state of nervousness, which is very unfavourable to the production of such respiration as is fitted to produce audible sounds. We know, besides, that this state of nervous disturbance is injurious in other respects. There is a calm, simple, benevolent mode of accosting a patient, a certain gentleness and earnestness of manner, that at once wins his confidence, and renders him composed, so that he answers correctly, does what he is desired well, and that his features, influenced only by the morbid state, express accurately all he feels.

9. It is important in each examination, to pass over every point of the chest, especially when we do not find at once the reason of the general phenomena observed. It often happens that it is in the top of the armpit or in the supra spinal fossa, or in some other very limited spot, we find the signs of a pneumonia which we have in vain sought every where else; at other times we discover in this way some complication of a pulmonary catarrh, which would in itself have been sufficient to explain the general phenomena observed.

10. There are certain fugitive sounds, heard now, and no longer audible a moment after. This character of inconstancy is one that it is sometimes important to ascertain accurately; for example, to distinguish the fine mucous ronchus from the crepitant ronchus of pneumonia; hence a precept, applicable to some cases only, to make a second examination a short time after the first. It is also necessary to examine the patient once at least in twenty-four hours, especially during the acute period of the disease, otherwise we might miss the successive changes that some sounds undergo, and mistake the course of the malady.

11. There is often danger in trusting too much to medical tact, and allowing oneself to be swayed by the feeling of pride which results from recognizing the nature of the disease, by the mere inspection of the patient's face. If we are mistaken, which sometimes at least happens, we have placed the senses in a false position, with respect to the mind, and too often, with the utmost anxiety on our part to go right, it will occur that they see and judge according to its premature decision. In such a case, the mucous ronchus is easily taken for the crepitant, &c. It

is only men grown old in practice, that find their first impressions sufficient for forming a correct decision.

12. The auscultatory examination being made according to the preceding conditions, its results compared with the assemblage of general symptoms presented by the patient, the different combinations of these signs properly analysed, it seldom happens that we cannot arrive at the exact determination of the disease with which the lungs are effected.

13. M. Louis * insists with reason on the importance of observing in the comparative auscultation of the right and left sides, exactly the same conditions on both sides; for a slight difference in the conditions, is often sufficient to vary the result, at the time that the lungs are equally healthy.

14. There is a circumstance connected with immediate auscultation, upon which authors have not observed, and which is however of some moment; it is the degree of pressure the ear ought to make on the parts examined. Some experiments on this subject have given me the following results:—1st. In the healthy state, if the ear be strongly pressed against the walls of the chest, the respiratory murmurs are heard less pure and less distinct. 2nd. If it be too lightly applied, the result is the same. 3rd. In the auscultation of the voice, in a person in health, it is heard very pure when the pressure of the ear is somewhat strong, and in other respects regular. 4th. It changes if the pressure be increased, and especially if too much air be confined within the ear, because this, by augmenting the tension of the membrane of the tympanum, alters its conditions of vibration. 5th. It changes still more, if the ear be but lightly applied; in that case, its *quality*, and its intensity are modified; it often takes the ægophonic character; the manifestation of this character is, in general, inversely as the pressure. These differences will be seen at once, by examining in a healthy person the right and left sides alternately, or the same point, with different degrees of pressure. If we were not aware of this circumstance, we might readily believe in the existence of ægophony, in a part where the ear had been applied lightly, and where we had reason besides to expect it. We know at the present day, that ægophony is a much rarer sign, and of much less value than Laennec thought; perhaps his mistake arose partly from the cause I have just pointed out. What would lead one to think so is, that he himself gives as a precept in searching for ægophony, to apply the ear but lightly on the stethoscope, remarking that it was not heard well except in this way. 6th. The different degrees of pressure of the ear upon the chest, have the same injurious influence upon the auscultation of the morbid, as of the healthy sounds. Hence this precept: *to apply the ear to the walls of the chest, so as to make moderate pressure, and not to confine too much air within it.* (6)

The glory of Laennec is not in the discovery of *mediate* auscultation; it is in the discovery of the thousand different sounds that occur in the diseases of the thoracic organs, in the analysis of these sounds, in the determination of the connexion between them and pathological anatomy, and in the order he discovered in the midst of this apparent confusion. The naked ear can reveal all the secrets of auscultation, as well as the stethoscope. It is even preferable as a general method. Notwithstanding what has been said by Laennec, who greatly exaggerated the importance of the stethoscope, immediate auscultation has the advantage in the greater number of circumstances; it is more convenient both for the patient and for the observer; it enables one to hear quite as well, often even more distinctly, and in as limited a space, the most delicate and most circumscribed sounds of the chest; it is not more exposed, sometimes indeed even less exposed, than the other to the production of accessory sounds; it enables us to recognise the nature of anormal sounds, quite as well as the stethoscope; lastly, it is more simple, and has less that air of display, which is so injurious to the physician in the opinion of the world. However, it is at times of use to have recourse to the stethoscope; it enables us, it is said, to hear some sounds better, for example, pectoriloquy, on account of its property of heightening the sounds that traverse it. I avow that, even in this respect, it has not appeared to me to add any thing to the certainty of the judgment we form in making use of the ear alone. The only circumstances in which it has seemed to me *necessary* to employ the stethoscope, are those in which we have to examine regions to which the ear cannot be conveniently applied. M. Andral, who will not certainly be accused either of partiality or inaccuracy in observation, confines the use of the stethoscope to nearly the same cases*. The authors of the Compendium de Medicine Pratique † express also the same opinion. (7)

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* Clinique de l'Hop. de la Pitie, année 1836.

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* Note de la page 54 du 1re. vol. de l'edit. de 1837 de Laennec.

† Vol. 1, art. Auscultation, p. 466.

CHAPTER I.

PHYSIOLOGICAL SONOROUS PHENOMENA OF RESPIRATION.

PART I.

FUNDAMENTAL CHARACTERS OF THE RESPIRATORY SOUNDS.

§ 1. SOUNDS OF RESPIRATION IN THE DIFFERENT SECTIONS OF THE RESPIRATORY APPARATUS.

In a first movement, *inspiration*, the air passes into the different parts of the respiratory apparatus, from the mouth and nasal openings to the air cells of the lungs; in a second movement, *expiration*, which immediately succeeds the former, it traverses the same passages, in the opposite direction. During each of these movements, it produces in its passage a distinct sound:—1st. the inspiratory murmur.—2nd. the expiratory murmur. Those sounds are produced in all the sections of the respiratory apparatus at the same time, and with different characters in each. This difference in their characters is derived from the peculiar texture of the parts in which they are produced; their primary characters are modified along with this texture. These modifications in the primary characters of the respiratory murmurs, occasioned by the changes of texture or arrangement in the parts where they are generated, are so many signs of the diseases from which these changes result; but the modifications cannot be appreciated, unless we have previously ascertained the primary characters; and their value as signs of disease will be uncertain, if we have not determined beforehand the limits of the normal state: this is accordingly the first enquiry we shall enter upon. We will in another place (see 1st part, ch. vii.) endeavour to show that the sounds in question do in point of fact originate in the parts of the respiratory apparatus assigned as their seat; but whatever be the theoretic view adopted on this point, the sound heard, its normal characters, its morbid modifications, and its value as a sign, remain still the same: in this case, practice has nothing to fear from the errors of theory. I will now proceed to consider each section of the respiratory apparatus separately, and to investigate—1st. the characters of the inspiratory and expiratory sounds in each; 2nd. the successive alterations these sounds suffer, the differences they present in these different sections; 3rd. the relation between these alterations and the differences in texture of the parts where they originate; 4th. we will afterwards enquire whether the sounds produced are exactly the same on both sides, and here we will examine comparatively the anatomical conditions of the two lungs.

VESICULAR SECTION.

Inspiration.

1st. The proper character of the inspiratory sound is a light *breathing* or *blowing*. This breathing is pure, without an admixture of any accessory sound; it is successive in its duration, but it does not give to the ear the sensation of the developement of the vesicles of which the lung is supposed to be formed. I have convinced myself, by repeating the experiments on healthy individuals, of all ages and all degrees of strength, that we will never find natural respiration, if we seek for a vesicular character in it; that is to say, the distinct sensation of isolated vesicles, which are dilated one after another. The vesicular character is essentially morbid; it is the type of certain ronchi, the existence of which demonstrates a morbid change in the state of the pulmonary cells. The expression, *vesicular murmur*, employed by some writers to designate the normal murmur of respiration, does not therefore correspond to the mode in which the respiratory sounds are produced, to the sensations they excite, but to their presumed seat.

2nd. The duration and intensity of the inspiratory murmur are two characters which it is very important to appreciate well, on account of the symptomatologic value they may present. To avoid the inconveniences of a nominal valuation of these characters, a *nominal* valuation which leaves no limit in the mind, and which cannot furnish an unit of measure sufficiently exact to enable us to compare with it the modifications that these characters suffer, I have had recourse to a *numerical* valuation; that is, I have expressed in figures the degrees of intensity and duration of the respiratory murmurs. The intensity and duration of these sounds vary very little in a state of health. They present, in the adult, a mean which is nearly always the same, and to which therefore the fixedness of the mode of valuation I propose is well adapted. I have investigated this mean in a great number of individuals, and have arrived at this result: that inspiration compared with expiration is represented in its intensity and duration by the number 10. It is of little importance whether or not this number be an *absolute* representation of the inspiratory murmur: it is intended chiefly to denote the ratio between the duration and intensity of inspiration and expiration. It represents a fixed point above or below which we may be carried in the morbid state. This relative appreciation is alone important to our object.

The number 10 expresses at once the intensity and duration of inspiration: in the physiological state, these two properties of the respiratory sounds always continue equal.

3rd. The gentle breathing that constitutes the inspiratory murmur leaves upon the ear an impression of softness, of smoothness, of free and easy expansion, with which it is important to familiarize oneself, the alteration of this character being a most valuable sign in many circumstances.

4th. The inspiratory murmur does not give the sensation either of dryness or of humidity; it is something between both. We will find that the character of dryness or that of humidity may be developed in it, and acquire a certain diagnostic value.

Expiration.

1st. Expiration, like inspiration, is represented in its proper character by a pure and gentle murmur. This murmur is even more continuous, less successive than that of inspiration. The term *vesicular*, in any other sense than as indicating the seat of the sound, is still less applicable here than in inspiration.(8) In proportion as the expiratory murmur undergoes an increase in its intensity and duration, the continuous character of this sound is a little changed, as we shall hereafter see; it then seems composed of small successive periods, of little continuous jerks; but still there is nothing of the sensation of vesicles that are dilated.

2nd. The duration and intensity of expiration are equal, and are represented by the same number. This number is much smaller than that of inspiration; it is only 2. As has beeen already remarked, it is employed to represent the ratio between inspiration and expiration, considered with regard to their duration and intensity, rather than the absolute limits of those characters. This relation between the intensity and duration of the two murmurs is of great importance, because the changes that occur in it furnish valuable signs in the majority of the diseases of the lungs. Hence I have taken much care to determine it accurately. I have examined with this view a great number of persons differing both in age and constitution, and the numbers 10 and 2 have appeared to me to express best the comparative intensity and duration of the two respiratory murmurs. The ratio of 1 to 5 is the same as that of 2 to 10; but I have chosen the latter because it affords a longer scale of increase and decrease, above and below these two extreme limits; by means of it we estimate more accurately, more progressively, the successive modifications, either in the way of increase or of decrease, that take place in the intensity and duration of the respiratory murmurs. We can thus construct a scale of the alterations of these murmurs above and below the normal type; a scale of which each degree, marked by a number, corresponds to a certain degree of anatomical and physiological alteration in the organ. In this way we appreciate more accurately, more consecutively, the symptomatology; we distinguish more easily the degrees, the delicate shades of the same symptom which may be in turn a sign of this or that disease; we follow, in a more regular and more secure manner, its increase or decrease; we avoid the phrases, *a little more, a little less, much, moderately*, the limits of which vary with each observer; and lastly, we employ a language which is equally easy to all the world: we derive from it besides this great advantage, that all observations made on this plan are exact, and capable of being compared with each other. It is true that several physicians examining the same patient, will not always arrive at precisely the same number; but with all who have had some experience of this method, the differences, if there be any, will not exceed one or two degrees, and hence can never vitiate the result.

3rd. The sensation of softness, smoothness, freedom, the absence of any marked sensation of dryness or of humidity, belongs to this as well as to the inspiratory murmur.

The normal rhythm of the inspiratory and expiratory murmurs is known to all; the strong and prolonged murmur first, the feeble and short one afterwards. I only allude to it here, to prepare for what I shall have to say hereafter on the alterations of this rhythm.

It is plain then that all the fundamental characters of the inspiratory and expiratory murmurs are in a great degree common to both, and that they only differ in respect to their intensity and duration, which are in the ratio of 2 to 10.

THE BRONCHIAL, TRACHEAL, LARYNGEAL, PHARYNGEAL, BUCCAL, AND NASAL SECTIONS.

1. *Normal bronchial respiration. The differential diagnosis between it and morbid bronchial respiration.*

The sounds I have just described are heard at all points of the thoracic walls, but more pure and more developed in proportion as the part examined corresponds to the greater thickness and greater functional activity of the pulmonary tissue; for example, in the antero-superior regions of the chest. Wherever a thick layer of pulmonary tissue covers the large bronchial tubes, such is the effect of the vesicular inspiratory and expiratory murmurs, that the sounds produced in the bronchi and in the trachea are quite inaudible, as long as the pulmonary tissue is pervious to air. But if the air cells for some extent are compressed, so that the air ceases to penetrate them, then the preceding murmurs are no longer heard, and the sounds which depend on the passage of the air through the bronchi, through the trachea, make their appearance, more distinct in proportion as the pulmonary tissue has become a better conductor of sound, (by means of its increased density), and as they are no longer masked by the murmurs of the vesicular respiration. These conditions may be met in the normal state, and enable us to appreciate the nature of the respiratory sounds in the bronchi, &c. This study is important, because it teaches us to distinguish them from nearly similar sounds that originate in the morbid state. There exists, in fact, between the two an essential difference, arising from the difference of the conditions in which they are produced: when morbid bronchial respiration is heard, (pneumonia in the 2nd. stage), there is at the same time cessation of the vesicular respiration, and more complete transmission or perhaps even augmentation of the sound in consequence of the induration of the pulmonary tissue; in normal bronchial respiration, such as we hear when we apply the ear at the root of the lungs, the latter condition does not exist at all, and the former exists in a much less degree; in fact, vesicular respiration is produced at a very short distance, or sometimes even all round, in a thin layer of pulmonary tissue. In some persons, normal bronchial respiration is not heard, even at the root of the lungs, however attentively we examine; this circumstance appears to depend on this, that in such cases, the bronchi instead of being quite exposed, are covered with a layer of pulmonary tissue, so thick, that the vesicular respiration masks entirely the bronchial; in fact in those cases we distinguish a feeble respiratory murmur. We sometimes observe in the numerous autopsies the hospitals supply, the anatomical disposition I allude to; but it is necessary to be aware of its existence in order to remark it, for in general it escapes notice.

The part of the posterior region of the chest corresponding to the root of the lungs is the only place, in general, that normal bronchial respiration can be heard, and furthermore this point is much more circumscribed than is usually supposed. The great number of persons I have examined in reference to this matter, and the care with which those examinations were made, lead me to think that theoretic reasoning, or indeed some oversight as to certain morbid conditions in the cases examined, has tended much to produce the contrary opinion (9). To be certain that all the facts put forward in this chapter really belong to the physiological state, I have repeated each of my observations, on military men, well formed and in the constant enjoyment of good health, and the results have been the same as with other persons.

It has been said that, in many persons with sound lungs, a little of the bronchial character is audible in the normal state, in the region of the spine of the right scapula; I have never met this.

The normal bronchial respiratory murmur differs from the morbid bronchial; 1st. in its intensity, which is much less, and, in general, never passes what we shall hereafter call *the first degree* of the bronchial character; 2nd. in its duration, which is shorter; 3rd. in its *quality*, which is much less marked, and which seldom rises above the lowest degrees of bronchial *quality;* 4th. in its exclusive and very circumscribed seat at the root of the lungs; whereas the morbid bronchial character, which may exist in any part of the chest, appears in this part much more rarely than in any other; 5th. in its co-existing more peculiarly with the period of expiration, while the morbid bronchial character, at a somewhat higher degree, co-exists equally with both periods. One of the general facts, presented by both the normal and morbid bronchial characters, is that of rising gradually to a state of greater intensity, co-existing in their first degrees with expiration alone, and not accompanying inspiration until they have attained their higher degrees. Now, the normal bronchial character, which

The normal resonance of the voice is somewhat more marked in front than behind, somewhat more at the summit than the base, but equal on both sides. The position of the patient, whether upright or horizontal, has no influence on its degree.

The vocal resonance is in general somewhat stronger in persons in whom the voice is manifestly grave; it is less when the voice is a little sharp or infantine. It is more distinct when the chest is thin, but well and strongly formed, than when it is fat, narrow, and slightly made. M. Andral* and M. Cagniard Latour have obtained the same results.

Opposite the root of the lungs, in the middle of the dorsal region, the normal resonance of the voice is more marked than any where else. (12) (For the normal resonance of the cough, see hereafter.)

§ 3. NORMAL RESONANCE OF THE SOUNDS OF THE HEART IN THE SUB-CLAVICULAR REGIONS.

In the normal state, the sounds of the heart are heard somewhat more distinctly under the left clavicle than the right. This difference, though slight, is very clearly perceived by immediate auscultation. In short, this readier transmission of the sounds of the heart to the left than the right clavicle is quite simple, since the conditions of conductibility being the same in both lungs, the heart is more distant from one of the summits than from the other. But the conditions of conductibility may change; the top of the right lung may become indurated, either alone, or to a greater degree than the top of the left; then the sounds of the heart are more distinctly heard under the right clavicle than under the left; hence a sign of which we will make use in judging of the comparative state of the summits of the lungs. The mere equality of the resonance of the heart's sounds under both clavicles may even, in the majority of cases, be considered an indication of an increase of density of the top of the right lung. We will make use of this sign particularly in the diagnosis of the first stage of phthisis pulmonalis.

ARTICLE II.

PHYSIOLOGICAL VARIETIES OF THE RESPIRATORY SOUNDS.

Without passing the limits of the physiological state, the fundamental characters of the inspiratory and expiratory murmurs may exhibit different varieties, or suffer certain modifications, which it is necessary to know, in order that they may not be confounded with the morbid changes of which these murmurs are susceptible. I will not go over each of these a region very remote from that to which the ear is applied; that its *quality* is buccal or pharyngeal instead of being bronchial; and lastly, that we can sensibly modify it by making the patient change the form and diameter of the openings of the mouth and pharynx, and by diminishing the velocity with which the air passes through those parts. Sometimes too we are sensible that it is the ear that is free that hears these sounds, and not the ear applied to the chest; now this never occurs in the case of the bronchial character, or of the sounds of the vesicular section.

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* Diction. de Medicine, p. 660.

The different varieties more or less transitory that may be met with in the nasal, buccal, pharyngeal sounds, appear to depend chiefly on the three following circumstances:—1st. on the degree of velocity with which the air passes through the mouth, the nasal passages and the pharynx; 2nd. on the relative or absolute degree of narrowness of the mouth and nostrils; 3rd. on the passage of the air more or less in a direct line, in a perfect column, or in a column broken against the pharynx. Thus, the sound is more nasal and buccal in proportion as the velocity of the air is greater, and the nasal and labial openings are narrower; it is more exclusively one or the other, in proportion as these conditions are found united in one of these openings, the other remaining in its normal state; and it is more pharyngeal in proportion as the column of air is more rapid, the mouth more widely opened, and the veil of the palate more raised; then in fact the column of air strikes directly upon the pharynx, and resounds but little on the two preceding portions of the respiratory passages.

I will not dwell upon the auscultation of the larynx in its normal state more than on that of the pharyngeal, buccal and nasal sections, because, as we shall see hereafter, the direct auscultation of this organ is scarcely of any use in the diagnosis of its diseases; it is sufficient to know that in the normal state the laryngeal inspiratory and expiratory sounds consist each of a very strong murmur, equal in both periods, the intensity and duration of which may be represented by the number 20.

III. *Relation between the differences presented by the sounds in the different sections of the respiratory apparatus, and the different texture or arrangement of each of these sections.*

The differences which the respiratory sounds present in the different sections we have been considering, appear to depend chiefly on the differences of texture that exist in those parts. If the object and limits of this work permitted me to enter into considerations of this nature, we would, with the aid of physics, find in the greater number of cases, an intimate relation existing between the successive increase in the intensity, the duration and the *quality* of the murmurs, and the successive increase of the diameters of the air passages, the more vibratory nature of their walls, as well as the mass and the increased velocity of the column of air that traverses them. We would find their transmission to a greater distance and their greater distinctness explained by their more superficial position, and the more favourable conditions for conducting sound by which they are surrounded; but it is sufficient in this general view that we place each physiological or morbid phenomenon in juxtaposition with the anatomical fact to which it corresponds. What a difference between the texture of the pulmonary vesicles, and that of the mouth and pharynx! What an interval between the vesicular murmurs, and the buccal and pharyngeal! In the one case, a delicate yielding tissue of feeble conducting power, cells of small extent; and, corresponding to this, gentle murmurs, neither dry nor humid, soft, of little extent, and little intensity, perceptible only by direct auscultation. In the other case, large cavities with dense and elastic walls, and surrounded by organs that augment the sounds; and then murmurs of great intensity, of much greater extent, clear in *quality*, and easily perceptible by auscultation at a distance. The difference between the anatomical changes that may occur in these different sections is very great; the pulmonary tissue formed of little cells full of air, may pass through all possible degrees of condensation or of rarefaction; the cavities of the mouth and pharynx can only increase or diminish a little in diameter; but again how limited are the modifications that can occur in the buccal and pharyngeal sounds, how numerous are those we observe in the murmurs of the vesicular section!

IV. *Are the respiratory sounds the same in the two sides of the chest, and in the different regions of the same side?*

An important question arises: are the respiratory sounds the same in both sides of the chest, and in the different regions of the same side? If a natural difference exists, it may be mistaken for the commencement of a pathological state, and hence will result errors in diagnosis. Two different ways conduct to the solution of this question:—1st. the direct and comparative observation of the sounds produced; 2nd. the comparative examination of the texture of the two lungs, and of the conditions of conductibility, by which they are surrounded; we have just seen, in fact, that a difference in the anatomical composition of the different parts of the same tube produces remarkable differences in the sounds that are formed there.

A. Attentive auscultation of different parts of the same side of the chest, in healthy persons, shows that the inspiratory and expiratory murmurs are in general more distinct in front than behind, and in the superior than the inferior lobes. In proportion as the sound becomes more intense and more distinct, we find that of expiration in particular take a character of greater clearness. This result agrees with an anatomical observation made by M. Cruveilhier.* That accurate observer remarks that if, after death, a certain quantity of air be thrown into the bronchi, it penetrates more easily and more rapidly into the superior lobes of the lungs; whence he draws this inference, that in the habitual state, the cells of these lobes take a greater part in respiration than those of the inferior lobes.

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* Laennec, Aus. Med. ed. de 1837, note de M. Andral, vol. 1, p. 647.

B. I examined a great number of persons in the medical and surgical wards, who presented every appearance of healthy lungs, and found in almost every case *that the inspiratory and expiratory murmurs were exactly the same on both sides of the chest*, at the superior as well as at the inferior part, in front as well as behind. The few individuals in whom I found the expiration a little more developed under the right clavicle than the left, were those precisely who were calculated to excite some doubt as to the state of their lungs. To satisfy myself on this point, I afterwards selected, in the military wards, persons who had all the appearance of robust health, and who had been brought to the hospital by diseases very different from those of the thoracic organs; in this way I satisfactorily ascertained, that in a state of health, the respiratory sounds are equally audible on both sides of the chest. It results from this *that whenever we find a difference between the murmurs at the summits of the lungs, this difference may, in general, be attributed to a pathological condition*. (10)

C. I have made some anatomical investigations, with the view of ascertaining whether there exists any difference in texture between the two lungs, which could have an influence on the normal sounds of these organs. I selected for this purpose the lungs of well formed adults, who had never suffered from any disease of the thoracic organs, and in whom the lungs were quite sound and the chest well formed. I have repeated these investigations several times on the lungs of men and women, and have arrived at the following results:

The two thoracic cavities, carefully measured, present no difference in their transverse diameters.

The summits of the two sides are on the same level, and the capacities of these summits are equal.*

The conditions of conductibility of sound are the same on both sides; or at least we cannot discover any circumstance to make them differ sensibly.

The tops of the two lungs are equal in volume.

No perceptible difference as to density of tissue can be discovered.

The mean length of the trachea, from its origin to its bifurcation, is three inches; it is composed of twenty cartilaginous rings.

A horizontal line, touching the summits of the two lungs, meets the trachea at the union of its two upper thirds with the lower. The two upper thirds are two inches long, and comprehend fourteen rings; the lower third is one inch, and contains but six.

If a transverse incision be made through the tops of both lungs, at the same level, it is evident, whether the bronchi be injected with solid matter or not, that the openings of the bronchial system are of the same diameter on both sides. If there be a difference, it is so trifling, that it may in fact be considered doubtful, and as of no importance as regards the change it could produce in the respiratory sounds of the side where it is supposed to exist.

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* The difference in vertical extent between the right and left side depends on the bas and not on the summit.

The transverse diameter of the trachea, at its bifurcation, is thirteen lines*; the transverse diameters of the origins of the bronchi is six and a half lines for the right and six lines for the left; hence a difference between them of one line only.

The bronchus of the superior lobe of the right lung is five lines at its origin; those of the inferior lobes of the same lung are each five and a half.

Each of the two bronchi distributed to the superior and inferior lobes of the left lung, is at its origin from six and a half to seven lines in diameter. In conclusion, we see that the sum of the diameters of the large bronchial tubes of the left lung is very nearly equal to the sum of the diameters of those of the right lung; and that the small bronchial tubes of the summits of the lungs do not present any sensible difference either. The diameter of the trachea in its superior portion is three lines less than at its bifurcation; and yet the most careful auscultation of these two points alternately, could not detect any appreciable difference between the sounds produced in them. *A fortiori* there should not be any difference in this respect between the bronchial tubes at the right and left sides, the sums of whose diameters vary only from half a line to a line.

The conclusion from the anatomical facts I have detailed, is that there is no sufficient reason, in the physical conditions of the organ, for any sensible difference between the normal sounds of the summits of the right and left lungs. We find, moreover, by contrasting the pathological changes with the symptoms, in certain cases of dilatation of the bronchi, that the production of the bronchial character of respiration is owing less to the increased diameter of the bronchial tubes, than to the induration of the tissue of the lung round the dilated bronchi. The bronchial character is usually quite imperceptible in those cases where the pulmonary tissue has not suffered any appreciable alteration, and where the bronchial dilatation is slight; it increases in proportion to the increase of diameter in the bronchi and of condensation in the surrounding pulmonory tissue, because the latter circumstance is almost always inseparable from the former. We should also remark that the uniform and more or less general dilatation of a part of the bronchial system has but very little influence in the production of the bronchial character, which is chiefly produced by partial and irregular dilatations. Now, the difference in diameter that exists between the bronchi of the right lung and those of the left is extremely trifling in the large branches, and almost nothing in the others. This comparative dilatation of the large bronchi of the right side is uniform and general; it is not accompanied by any difference of density in the surrounding tissue; consequently it is incapable of producing any difference between the sounds of the two sides. I had already, as I said before, arrived at the same result from the comparative examination of these sounds.

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* This diameter is but 10 lines in the superior ⅔ of the tube.

The right bronchus and its first divisions have neither the same extent nor the same direction as the left bronchus and the two trunks into which it is divided; but these circumstances produce no sensible difference in the results of auscultation practised at these two points. (11)

§ 2. NORMAL RESONANCE OF THE VOICE THROUGH THE WALLS OF THE CHEST.

Writers are by no means agreed as to the degree of the normal resonance of the voice through the thoracic walls. However, as this resonance may sometimes be an important sign, for example, in the diagnosis of the first stage of phthisis, it is right to determine the limits of the normal and of the morbid state. It is indeed difficult to fix this limit absolutely, because an almost imperceptible gradation leads from the one to the other; however, the practise of auscultating the voice in the healthy and in the diseased condition, the practise of comparing these with each other, enables us to determine with tolerable exactness, in the majority of cases, even to slight shades, whether the form and degree of vocal resonance observed belongs to the normal or the morbid state. In immediate auscultation the resonance of the voice is stronger than in mediate auscultation. This circumstance may have contributed to make Laennec consider the vocal resonance feebler than it really is. According to him, this resonance is *scarcely at all perceptible**. This expression appears to me exaggerated. The general result I have obtained is as follows: one ear being applied to the chest of a healthy person, while he is speaking or counting, and the other ear being closed with the finger, we hear a tolerably strong, somewhat obscure murmur, a kind of buzzing, not reproducing with distinctness the words of the individual; this sound, which has a kind of jerking character, seems to occupy a large surface, coming from all sides, but irregularly, to concentrate itself beneath the ear. In bronchophony, even in a slight degree of it, the sound appears to pierce straight through the lung, in its passage to the ear; the rays of sound which compose it form, as it were, a body more compact, and concentrated into a smaller volume; the sound produced occupies less space beneath the ear, and this organ, as if struck in a single point, feels a more strong impression. The sound is more distinct, more piercing, its *quality* is more clear, a little metallic as it were; but the words of the patient continue always indistinct.

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* Auscult. Mediate; edition de M. Andral, vol. 1, p. 83. Laennec by Forbes, p. 38, 3rd edition.

is always confined to a low degree, is for this reason scarcely ever heard except in expiration; whilst the morbid bronchial character, when a little elevated, co-exists at once with both inspiration and expiration. The differential diagnosis between them will then be possible, by this means, when the sound in question has much intensity; but it will not be so, whenever the bronchial character observed is at a low degree. I have never seen the bronchial character, normal or morbid, co-exist with inspiration alone. 6th. In the case I was supposing, where the morbid sound presents itself in its lowest forms, we may still distinguish it from the normal sound, by this character, that, in the latter, the inspiratory murmur is heard nearly pure, free from all change in its softness; whereas in the case of morbid bronchial character limited to expiration, the inspiratory murmur has acquired a peculiar character of hardness and roughness: this is what we see in the first stage of phthisis. The tumefaction, the melanotic degeneration of the ganglia which surround the large bronchial tubes and the termination of the trachea, produce at times the morbid bronchial character opposite the root of the lungs; but in such cases it usually presents a much greater intensity than the normal bronchial sound.

II.—*Tracheal, laryngeal, pharyngeal respiration.*

In proportion as we ascend to a higher section of the respiratory apparatus, to the trachea, larynx, pharynx, &c. the inspiratory and expiratory sounds tend more and more to become equal in respect to their duration and intensity, and at the same time pass, in respect to their *quality*, from a lower to a higher degree. This is particulary apparent when they are heard in the region itself where they are produced. I will not attempt to describe these successive shades of *quality*, of intensity, and of duration, for no very important practical result can be derived from them: the general facts included in this section are sufficient for all particular applications of any utility. Another fact of some importance is that the respiratory sounds are better heard at a distance, whether the ear be applied to the chest or not, according as they belong to a higher section of the respiratory apparatus; which probably arises from their being stronger, their *quality* being higher, and the organ in which they are generated being more superficially situated. If, while we are listening to the vesicular respiration, these sounds should happen to strike the ear, their *quality* and their intensity are a little modified by this transmission through the pulmonary tissue; they appear to fall to the lower degrees, and to an inattentive observer, they might strikingly simulate the morbid bronchial character; especially if the attention slumbered for a moment as to the existence of the vesicular murmurs, and if these should be naturally rather feeble: but the moment the attention is aroused to the action of the senses, we feel at once, that the sound heard comes from a region very remote from that to which the ear is applied; that its *quality* is buccal or pharyngeal instead of being bronchial; and lastly, that we can sensibly modify it by making the patient change the form and diameter of the openings of the mouth and pharynx, and by diminishing the velocity with which the air passes through those parts. Sometimes too we are sensible that it is the ear that is free that hears these sounds, and not the ear applied to the chest; now this never occurs in the case of the bronchial character, or of the sounds of the vesicular section.

The different varieties more or less transitory that may be met with in the nasal, buccal, pharyngeal sounds, appear to depend chiefly on the three following circumstances:—1st. on the degree of velocity with which the air passes through the mouth, the nasal passages and the pharynx; 2nd. on the relative or absolute degree of narrowness of the mouth and nostrils; 3rd. on the passage of the air more or less in a direct line, in a perfect column, or in a column broken against the pharynx. Thus, the sound is more nasal and buccal in proportion as the velocity of the air is greater, and the nasal and labial openings are narrower; it is more exclusively one or the other, in proportion as these conditions are found united in one of these openings, the other remaining in its normal state; and it is more pharyngeal in proportion as the column of air is more rapid, the mouth more widely opened, and the veil of the palate more raised; then in fact the column of air strikes directly upon the pharynx, and resounds but little on the two preceding portions of the respiratory passages.

I will not dwell upon the auscultation of the larynx in its normal state more than on that of the pharyngeal, buccal and nasal sections, because, as we shall see hereafter, the direct auscultation of this organ is scarcely of any use in the diagnosis of its diseases; it is sufficient to know that in the normal state the laryngeal inspiratory and expiratory sounds consist each of a very strong murmur, equal in both periods, the intensity and duration of which may be represented by the number 20.

III. *Relation between the differences presented by the sounds in the different sections of the respiratory apparatus, and the different texture or arrangement of each of these sections.*

The differences which the respiratory sounds present in the different sections we have been considering, appear to depend chiefly on the differences of texture that exist in those parts. If the object and limits of this work permitted me to enter into considerations of this nature, we would, with the aid of physics, find in the greater number of cases, an intimate relation existing between the successive increase in the intensity, the duration and the *quality* of the murmurs, and the successive increase of the diameters of the air passages, the more vibratory nature of their walls, as well as the mass and the increased velocity of the column of air that traverses them. We would find their transmission to a greater distance, seen, according to the diseases on which they depend, appearing in every point of the organ in which those diseases can exist; it is in this respect only that the consideration of their situation can have any interest. Thus, the diminution of the duration of inspiration, the augmentation of expiration, the character of hardness, of roughness, of crumpling in the respiratory murmurs, if found to exist over all the extent of the chest, or of one of its sides, may be regarded as depending on emphysema of the lungs. On the contrary, should they be localised under the clavicles, in the superior regions, it is probable they depend on tuberculization of the lungs.

ARTICLE II.

MORBID CHARACTERS OF THE INSPIRATORY MURMUR.

1. *Alterations by Augmentation.*

1st. The intensity and duration of the inspiratory murmur in its normal state being represented by 10, this number is a fixed point, above and below which we may construct a graduated scale, for the modifications by diminution as well as by augmentation. Those of diminution may fall to *zero*, where they take the name of *cessation:* this first scale comprises 10 degrees. We may make the second equal to the first, by taking 10 degrees above the number 10, and representing by 20 the maximum of augmentation of the inspiratory sound. Between these two extremes, there exists a sufficient number of degrees to enable us to express by successive numbers all the possible intermediate shades between the cessation of the inspiratory murmur and its highest elevation. Hereafter we will do the same for the expiratory sound. All the modifications of the duration and intensity of these sounds are thus expressed in language at once accurate, concise, and intelligible to all, and which has the advantage of placing before the mind the extent of physical alteration in the organ; for in the greater number of severe cases (and it is about those that the practitioner is chiefly anxious), the number that expresses the degree of the symptomatic modification, represents also with sufficient exactness the extent of anatomical alteration. In the first stage of pulmonary phthisis, for example, we see the expiratory murmur undergo a successive increase in duration and intensity, and pass from the number 2, which is its normal one, to the numbers 4, 8, 12, 15, 18, 20; and these successive numbers measure with sufficient accuracy the progress that the disease makes at the same time.

2nd. The duration of inspiration is never augmented independently of its intensity; thus in the respiration called *supplementary*, the augmentation affects at once both the intensity and the duration of inspiration and expiration. It may happen, on the contrary, that the duration remaining unchanged, the intensity increases; this occurs in tuberculization of the summits of the lungs.

3rd. A momentary nervous excitation, a physical circumstance such as panting, lastly, certain organic circumstances, may produce this augmentation of inspiration. I shall in this place speak only of that which is produced by the last class of causes. The augmentation of inspiration is never a direct effect of any organic alteration of the lungs; it is not even produced in the diseased part, but in the neighbouring healthy portion of the organ. It is that this healthy portion supplies the place of that which is no longer capable of performing its function: according as the part affected is more or less extensive, more or less diseased, the healthy part augments its efforts and its murmurs; hence the different degrees of supplementary respiration. If this exaltation of the respiratory sounds takes place in a part completely separated from the part affected, * the respiratory murmur, however elevated it may be, remains perfectly pure, and the increase affects equally the intensity and the duration; this is the case in ordinary supplemental respiration. But if the sound portion of lung be situated close upon the affected part, or indeed inclosed among diseased lobules, this proximity will impress certain special characters on the exaltation of the respiratory murmurs: thus the augmentation will especially affect the intensity, and certain modifications by perversion will be united with it: in fact, the morbid sonorous phenomena will then be formed in a complex, in a mixed state, on account of the two sources from which they are derived. For example, in tuberculization of the central part of the top of the lung, the morbid sounds produced there mingle with the pure but exaggerated sounds of the surrounding parts; and the result is an inspiratory murmur greatly increased in intensity, diminished or not in duration,—an expiratory murmur increased in both respects,—and each accompanied sometimes by the bronchial character, and always by some hardness and dryness.

From this explanation of the augmentation of the inspiratory murmur, it is plain this character must present itself in a very great number of different cases. It is enough to say, generally, that these cases will be where one portion of lung takes on the duty of another which is incapable of performing its functions.

4th. The physical characters of this augmentation of the inspiratory sound are those of normal inspiration, but exaggerated. I will hereafter examine particularly supplemental respiration, and point out its usual course and its differential diagnosis (see art. VIII.)

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* As, for example, in front, in pneumonia of the posterior parts; or in the right lung, when there is pleuritic effusion in the left side.

II. *Alterations by diminution.*

1st. From the number 10 inspiration may descend successively to *zero*. Unlike the phenomena of augmentation, the diminution of the inspiratory murmur is a direct effect of the particular physical condition of the respiratory organ; so that the number that indicates this diminution expresses exactly the degree of obstruction that exists to the accomplishment of the function: this holds as well for contractions of the larynx, of the trachea and of the bronchi, as for diseases of the lungs and pleura.

2nd. This diminution usually affects both the intensity and duration at the same time. It may however be confined to the duration, as occurs in the first stage of phthisis; but this is very rare, and besides it takes place only in cases where another morbid circumstance has altered in its own way the intensity of the inspiratory murmur, and in this manner separated it from the duration of the same sound. Thus, except when complex organic alterations act on the inspiratory murmur in different ways, the diminution of this sound affects at the same time its duration and its intensity.

3rd. The diminution of the inspiratory murmur is produced whenever there exists, in any part of the respiratory apparatus, an obstacle to the free entrance of air into the pulmonary parenchyma. These cases are very numerous: their enumeration would be almost a complete list of the diseases of the larynx, trachea, bronchi, pleura, and lungs. It occurs in pleurisy, in pneumothorax and hydrothorax, in the case of old false membranes enveloping the surface of the lung, in pneumonia, in chronic induration of the pulmonary tissue, in tuberculization, pulmonary apoplexy and emphysema, serous or sanguineous congestion of the lungs, intense bronchitis with considerable tumefaction of the bronchial mucous membrane; in the different thickenings of the laryngeal mucous membrane, in cases of false membranes secreted in the interior of the bronchial system, &c. It is met also, independent of all organic changes, in certain spasmodic affections of the inspiratory organs.

4th. We can appreciate by auscultation, by the impression made on the ear, whether the air passes freely forward into the pulmonary tissue, and to what extent the expansion of this tissue takes place. If a considerable pleuritic effusion compresses the lung, we feel, in some sort, that the air, after having penetrated some way into the bronchial ramifications, can go no farther; we feel that it then struggles an instant against the obstacle which opposes the dilatation of the air cells, and that, not being able to penetrate these, it effects a kind of dilatation *en masse* of the compressed pulmonary tissue, which is accompanied with a slight and quite peculiar sound. There is no word which exactly expresses this sensation; it must be felt: but it is of great importance to remark its degree, in order to know how far the disease has proceeded. In fact, if we follow the disease in its progress of improvement, we feel the pulmonary expansion increase more and more, the air penetrate successively deeper and deeper, in proportion as the effusion is absorbed, as the obstruction of the lung diminishes; and at the same time, the slight peculiar sound of which I have spoken disappears, and is replaced by the normal inspiratory murmur. I lately operated for empyema on two patients in M. Andral's wards, who had for a long time extensive pleuritic effusion. Before the operation the respiratory murmurs were totally extinct. We drew off gradually a part of the effused fluid with the canula; the rest escaped insensibly by the wound; the compressed lung by degrees resumed its normal volume so completely, that, in one of the cases, a pleuritic friction sound soon announced that the surface of the lung had regained its contact with the ribs. We followed attentively, with the aid of auscultation, all the gradations that the respiratory murmurs passed through in their return: we heard the slight sound I spoke of just now, a sound which announced the imperfect penetration of air, and the expansion *en masse* of the pulmonary tissue; we expressed by numbers, gradually increasing, the degree of penetration of air, and of the sound that accompanied it, and we ascended thus successively from zero, the state before the operation, to an inspiratory murmur almost completely natural, which might be represented by the number 8 or 9. In one of those patients a fresh pleuritic effusion took place at the other side: we followed, in the opposite direction, the successive diminution of the inspiratory number till it reached zero, when the patient died. In persons affected for years with chronic disease of the larynx, on whom I performed tracheotomy, the inspiratory murmur was almost at zero at the time of the operation, when the patient was on the point of perishing 'asphyxiated; afterwards we observed the gradual return of the inspiratory sound to its normal number, in proportion as the artificial opening produced by the bistoury permitted the air to penetrate into the lungs, or as the cure being effected, respiration was established by the natural passages.

5th. When inspiration has been for a long time in a state of diminution, and that, in consequence of the resolution of the disease, it rises by degrees higher and higher, it usually goes beyond its natural limit, and passes from diminution to augmentation. But I have ascertained that this takes place only in those cases where the resolution of the hepatized lung, instead of being simultaneous in the whole affected part, is successive, and does not take place in the inferior portions until it has been completed in the superior. The part where resolution is complete produces exaggerated respiration, until resolution takes place in a neighbouring part; this, in its turn, becomes the seat of puerile respiration, whilst in the preceding part the respiratory murmurs return to their natural limit. This phenomenon does not occur when resolution takes place at once by a uniform and simultaneous movement throughout the whole extent of the hepatized portion. Very lately, a patient who lay at No. 18 ward of Saint Louis (hospital of la Charite) afforded us an opportunity of confirming this general fact. He was in the stage of resolution of a pneumonia, which had occupied all the posterior part of the left lung. The resolution was effected in succession in the superior, the middle, and lastly the inferior third. We heard supplemental respiration at the upper part, when there was still almost complete absence of respiration at the base; then respiration quite natural at the top, when it was supplementary in the middle third, and just beginning to reappear at the bottom. It is scarcely possible to conceive how much the knowledge of the laws that govern the course of the morbid sounds tends to give confidence to the mind and security to the judgment.

6th. We have already seen, in the preceding general views, that the diminution of the inspiratory murmur may be simulated by different circumstances, independent of any physical lesion of the lung: we easily avoid any error by combining with auscultation the other means of investigation, which, by controlling its results, enable us to appreciate their value.

III. *Alterations by cessation.*

Pneumothorax, when somewhat considerable, affords a type of the complete cessation of the respiratory sounds; because in it no accessory sound comes, like the bronchial in pneumonia, to mask the period of inspiration and expiration, and leave the ear in doubt as to the complete or incomplete disappearance of the normal sounds. There are some cases of very abundant effusion into the pleura, of close confinement of the lung by thick false membranes, of chronic induration, of carnification of the pulmonary tissue, in which the cessation of the respiratory murmurs is complete, without the intervention of any accessory sound. In cases of this kind, the result of auscultation is entirely negative: the motions of the chest are almost as extensive as in the normal state, at least the motions of the entire cavity; but complete silence has replaced the murmurs of inspiration and expiration. In these circumstances, the expiratory sound is as completely annihilated as the inspiratory. But instead of the two normal respiratory murmurs, we still hear, in a certain number of cases, towards the end of the inspiratory movement, that slight sound, to which I have just now called attention, and which appears to result from the lateral effort the column of air which cannot penetrate into the bronchial ramifications, exerts on the compressed pulmonary tissue. The name, ***sound of pulmonary compression***, expresses perhaps sufficiently well the sensation felt by the ear. (13) I have not seen any case of disease of the larynx, of the trachea, or of the bronchi, in which there was complete cessation of the respiratory murmurs: this total negation of the murmurs is only remarked in the last moments of life. We know, in fact, that the patients always die before the contraction is complete, and that, in cases of this kind, the immediate cause of death is as much the want of nervous action, as the absolute and physical impossibility of the penetration of air into the lungs.

IV. *Alterations by perversion.*

1°. ***Rhythm.*** The inspiratory murmur, considered separately and independently, is in its natural state the result of a uniform continuous motion. This is what constitutes its normal rhythm. Now, this rhythm may change. In acute pleurodynic pain, the inspiratory murmur becomes brief, abrupt, jerking, composed of several successive and unequal periods; we are sensible that the sound begins and is interrupted abruptly, on account of the sudden effort the patient makes to stop a motion that excites pain. The inspiratory murmur participates, in some degree, in the convulsive state of contraction of the muscles. Amongst the different characters I have now indicated, there is some one that predominates; most frequently it is the quick, jerking character. In general the inspiratory sound is diminished, the expiratory a little increased.

In the commencement of pleurisy, the respiratory murmurs usually present themselves in a form nearly similar, insomuch that the differential diagnosis of these two affections is at this time impossible by auscultation. In some cases, however, we detect differences between the respiratory sounds in these two affections, so striking as to enable us by their means to suspect the real disease: thus we sometimes find in commencing pleurisy the inspiratory murmur as it were uniformly compressed, arrested in its developement with a kind of regularity, dull, deep, and distant. I am wrong perhaps to enter into the detail of these sensations, since a technical expression is wanting to designate their distinct physical character: however, these sensations have still their value; with an attentive ear, every one may find them, and we will often see that, in the absence of more certain signs, they contribute very much, by the general impression they leave, to the conclusion at which we arrive.

In those cases where inspiration has suffered the changes of rhythm I have just described, expiration usually remains unalterd. We may indeed conceive that it must be so, since the movement of expiration, compared with that of inspiration, is almost entirely passive: it is a period of repose for the patient; the pain is extinct during this period, so that the movement and the sound that accompanies it are produced with freedom. Frequently the patient even prolongs this period, either by gently drawing out the expiration, or by creating each time a distinct moment of repose between it and the succeeding inspiration.

2°. ***Quality*** (*Timbre*). The alterations the respiratory sounds suffer in their *quality* are numerous, and require to be well known, as well separately, as in their relations to each other. I shall here consider them with reference to the inspiration, briefly pointing out the general principles by which they are governed. These general principles, as well as the particular remarks will be, for the most part, as applicable to expiration as to inspiration.

The *gentle breathing*, the *soft murmur* which characterizes the respiratory sounds in the normal state, may, under the influence of some organic changes, take on a certain number of morbid characters, which affect chiefly the *quality* of these sounds, and which, for that reason, I will unite under the collective name of *alterations* of *quality*. There are, in these alterations of *quality*, successive degrees which lead, by a considerable number of gradations, from the most simple to the most elevated forms. They are, as it were, so many degradations of a common type, which recals the sensation of metallic *quality*, and which I will designate by that name. The signs which Laennec has described separately under the names of *cavernous*, *blowing*, *amphoric* respiration, and under that of *metallic tinkling*, belong to this type; those which I will call the *clear character* and the *resonant character* belong equally to it, and mark its first degrees. All give to the ear a sensation of something metallic; only this sensation is produced by each in a different degree; we see them in certain diseases follow one another in order, and sometimes appear in succession from the first shade to the last. From the moment the first trace of bronchial character appears, till amphoric resonance or metallic tinkling strikes the ear, there is an unbroken but graduated chain; there is a successive passage from one degree to another, but no change of nature.

Certain fixed physical conditions invariably correspond to this symptomatic state. Let us examine all the cases in which the metallic quality is manifested, under any of the preceding forms, and we will always find coinciding with it the two following physical circumstances, either single or combined: 1° condensation of the pulmonary tissue; 2° augmentation of the diameter of the cavities in which the air moves. The effect of the first of these two circumstances is:—1° to diminish very much or entirely destroy the sounds of vesicular respiration; 2° to place, in the course of the sounds which arise naturally in the bronchi, a good conducting body, or perhaps even a sort of organ which strengthens the sound, which modifies its form or degree, in proportion to the different forms and degrees of this condensation, in proportion to the possible combinations between this and the preceding circumstances. A proof that the presence of a good conductor of sound is an indispensable condition to the production of alterations of *quality*, is that no such alteration is met in simple pneumothorax, notwithstanding the state of compression and the increased density of the pulmonary tissue; in this case the alterations of *quality* and all the *morbid sounds* which arise are arrested at the surface of the lung by the atmosphere that surrounds it. Accordingly, the results of auscultation are entirely negative in this affection.

Melanotic indurations of the lungs, their carnification, their different degrees of hepatization, their infiltration with tubercles, their compression by a liquid effusion, the excavation of the pulmonary tissue in cavities more or less numerous, of greater or less extent, the simple dilatation of the bronchi, &c., are so many circumstances in which we recognise in the living the alterations in *quality* of which I have spoken, and on the dead the two anatomical characters that I have said correspond to the symptom.

Thus, whenever alterations of *quality* appear in the normal murmurs, they correspond to a condensation of the pulmonary tissue, and sometimes, at the same time, to an augmentation in the diameter of the bronchial tubes, or to the formation of accidental cavities in the pulmonary tissue; but it does not follow, that because these circumstances exist, the phenomenon must always exhibit itself. Thus, when pleuritic effusion becomes very abundant, the bronchial character disappears. Thus too I have not found any trace of it in individuals, who yet after death presented a thick false membrane almost cartilaginous covering the surface of the lung.

It will be seen that instead of describing the bronchial, the cavernous, the amphoric characters, &c., as so many isolated and independent phenomena, as Laennec did, I have placed them all in the same class, bringing into view the common chain by which they are connected, and in consequence of which they are all merely successive degradations of the same type. The following is the scale of these degradations; 1° Metallic tinkling, 2° Amphoric character, 3° Cavernous character, 4° Bronchial character, 5° Blowing character, 6° Resonant character, 7° Clear character.

1st. When the normal sounds of respiration begin to pass through the series of alterations of *quality*, the *clear character* is the first that strikes the ear. This expression in itself sufficiently describes the sensation felt. The murmur of puerile respiration exhibits tolerably well this character. In speaking of exaggerated respiration (see this ch. art. viii.) I will point out how they may be distinguished. The clear quality is usually met with when the sounds produced by a central hepatized portion of lung, are mingled with those of the healthy parts that surround it.

2nd. When the respiratory murmurs which are still produced in the interior of a lung are obliged, in their passage to the ear, to traverse a layer of pulmonary tissue in which respiration is extinct, they convey a peculiar intonation which a practised ear recognises at once, and which gives the impression of having come from afar. The word *remote, remote character*, seems to me to express this sensation best. It approximates closely to what I have named the *resonant* character, which is but an exaggeration of the clear character, but a deeper shade in the alterations of *quality*.

These inferior degrees are not manifested at all, or at least are not observed in acute diseases, as pneumonia or pleurisy, because these affections produce very speedily considerable condensation of the pulmonary tissue: there is not time to observe these successive changes, or indeed sufficient attention has not been given to the matter. But in chronic diseases, as tuberculization of the summits of the lungs, the alteration proceeding slowly and by well marked gradations, each symptom exists for some time, so that we have an opportunity of satisfying ourselves of its existence and of its transformation.

3rd. The *blowing* character usually lasts but a very short time, and does not always shew itself; sometimes it is very feeble, and does no more than prepare for the bronchial character which soon follows it; sometimes it is very strong, persists a long time, and constitutes then the phenomenon with Laennec calls *blowing respiration*. It is a murmur with *a clear quality*, a murmur more or less strong, which gives usually the sensation of a column of air taken and thrown into the ear of the observer by the chest of the patient. It only wants a metallic *quality*, more strong, more distinct, to become bronchial, that is to pass to the next character.

4th. The *bronchial* character is the most frequent form of the alterations of *quality*. It is a sign of great value, because it is subject, in its rise, progress, and disappearance, to laws nearly constant; because the anatomical circumstances to which it corresponds, are always well defined; because the different degrees in which it appears represent with tolerable exactness the degrees of anatomical alteration. Accordingly, it is very important to appreciate its intensity, and it is easy to recognise three degrees of it. This character has been very well studied by authors, and by Laennec in particular. M. Andral has recognised several varieties. M. Grisolles* has described one which gives, he says, the sensation of the tearing of a piece of tabinet. It is particularly important to remember that the bronchial character may present various degrees, and it is, I think, more useful and more easy in practice to attend to these degrees, than to seek for differences in the nature of the phenomenon.

5th. By almost imperceptible shades, the bronchial may grow out of the clear, blowing characters, and pass itself into the *cavernous*; however, it is distinguished with sufficient accuracy, as well by its degree as by a peculiar impression it leaves on the ear, from the characters now mentioned. The ear, while it recognises that they are of the same nature, feels a difference between them: the intensity of the characters that precede the bronchial is in general but feeble; their *quality* is not distinctly metallic; on the contrary, the bronchial character produces on the ear an impression stronger, more marked, much more unlike the characters of the normal sounds, and its intonation is distinctly metallic. The cavernous character gives distinctly the sensation of the passage of air into a spacious and as it were rounded cavity; whilst the impression produced by the bronchial is quite that of an uniform tubular cavity traversed by a column of air. Emptiness of the cavity and of the bronchial system are the best conditions for the production of cavernous and bronchial respiration; because then the walls of the cavities vibrate more easily and more completely. We may say, in general, that these two characters are proportional to the degree of emptiness of the cavities in which they are produced. M. Andral has particularly insisted on this fact in reference to cavernous respiration.

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* Journal Hebdomad. des Progres des Sciences Med. No. 29, 1836.

In its most elevated forms, the bronchial character conveys the impression of the passage of air into very large tubes, especially when the pulmonary tissue has become very dense; this is seen particularly in infiltrations of miliary tubercles, which invade the whole mass of the lungs with such extraordinary rapidity, that they are in a short time converted into a nearly solid body. In these cases, it is easy to mistake the bronchial for the cavernous character: I was at first sometimes deceived in this way. The mistake was the more easy, as the idea of the cavernous character and of phthisis in its latest stage are so closely connected: I was astonished, on examination after death, not to find the smallest trace of a cavity. In carefully examining other cases of the same kind, and directly comparing the very clear and very strong bronchial respiration in these, with the real cavernous character, I observed that the latter, even in this case, maintained a peculiar *quality* which cannot be better expressed than by the word itself *cavernous;* the *quality* of the first, which is equally peculiar, would be perhaps better represented by the word *tubular;* this, as is obvious, refers to the sensation felt, in the one case, of an uniform prolonged cavity; in the other, of one more limited but more or less regularly rounded.

So true is it that this *cavernous quality* has something peculiar in it, that I have several times been led by it alone to suspect a cavity of the size of a nut in the centre of the top of one of the lungs, and in fact have on autopsy ascertained its existence and its isolation.

6th. It is only in cases that are very rare, of a vast cavern, regular in form and with firm and vibratory walls, communicating with the bronchial system by one or two very narrow openings, that the cavernous changes to an *amphoric character* sufficiently marked to enable one to infer the existence of hydropneumothorax with perforation; moreover, other signs, other modes of investigation, may in general put us in the right way. In a case of hydropneumothorax with perforation, of nearly a year's standing, the amphoric character was completely localized at the top of the right side of the chest, whatever was the position of the patient. If the previous history were not known, it would have been indeed difficult to say what affection this symptom belonged to: whether a vast cavity in the lung, or a perforation of the lung with effusion of air and liquid in the pleura; more especially as there was no metallic tinkling, and that gurgling was distinctly audible under the right clavicle

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(1) Clinique Medicale; 3 edit. tom. 4, p. 73.

(phthisis in the third stage). Hydropneumothorax with perforation and all the symptoms of it had existed in this case a long time; but by degrees the effused air and liquid were absorbed, the opposite sides of the pleura had contracted adhesions, this progress towards a cure had proceeded from below upwards, and the amphoric character, the sole remaining symptom, had taking refuge as it were in the top of the lung. The patient continued to improve; we saw the bronchial character successively diminish and disappear, the walls of the chest sink in, and the patient leave the hospital. He lay in Saint Louis' ward, hospital of La Charite, under the care of M. Andral.

7th. Laennec and some of those who have followed him have so well described metallic tinkling and amphoric respiration, that it is impossible to add any thing to what they have said on the subject. In chapter viii., however, I will give the result of experiments I made with the view of throwing light on the mechanism of these two sounds. We may give the name of *metallic resonance* to a variety of metallic tinkling, where this phenomenon, instead of being, as usual, an isolated and instantaneous sound, is prolonged for an instant, and resembles the sound which continues to be produced for some time after a bell is struck. This metallic resonance sometimes replaces altogether metallic tinkling; it is produced particularly towards the end of inspiration and expiration, and seems to depend on certain conditions of the fistulous opening; but these conditions are still undetermined.

Some writers* have admitted several species of metallic tinkling: one produced by the fall of a drop of liquid from the top of a cavity on the surface of the purulent fluid it contains; another produced by the same mechanism in the pleuritic cavity in hydropneumothorax, without perforation of the lung; and lastly, that which usually accompanies this complication of hydropneumothorax. I avow that I have never heard any but the last, and M. Andral has often told me it was the same with him. (14)

Laennec has described, by the name of *veiled blowing (souffle voilé)*, a phenomenon, with respect to which I must make the same observation as with respect to metallic tinkling from the fall of a drop from the top of a cavity on the liquid contained in it. In reflecting on the words of Laennec regarding this veiled blowing, as well as this particular species of metallic tinkling, one is led to think that it was from reasoning, from analogy, rather than from clinical observation, he derived these phenomena, and that his faculty of comparison, by which he seems to have been often happily guided to the anticipation of facts, was less fortunate on this occasion.

One of the facts that it is most important to be familiar with, in the history of the alterations of *quality* of the respiratory sounds, is the law that governs their co-existence with either period of respiration. Those alterations always appear first in expiration alone, and spread afterwards to inspiration; but as they are increasing in the first, while they are invading the second, it follows that, in general, they are always more marked in expiration than in inspiration. In their decrease and disappearance they follow exactly the same course, but in an inverse order, so that they have disappeared from inspiration at the time we have still traces of them in expiration. This is, therefore, first attacked and last abandoned. From the clear character up to the first degree of the bronchial, the alterations of *quality* may co-exist with expiration alone; but when the second degree of the bronchial character has appeared in expiration, the alterations of *quality* that precede this degree present themselves in inspiration. We have, in this peculiar and constant march of the sounds of this class, an excellent mode of judging of the progress the disease is making for the better or the worse. Suppose, for example, the first stage of phthisis: we are sure the disease is increasing if the bronchial character, after having co-existed for some time with expiration alone, makes its appearance in inspiration; we estimate afterwards the degree of this increase, from the more or less complete occupation of the two periods of respiration by the bronchial character, and by the successively higher forms it assumes.

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* Laennec, Auscult. Med. edit. d'Andral, vol. 1, p. 137. Louis. Recherches sur la Phthisie, p. 241. Williams, quoted by Clarke. Traite de la Consomption, p. 150.

In their first degrees, the alterations of *quality* occupy only the end of the inspiratory and expiratory murmurs; but in proportion as we rise in the scale of these alterations, we find them occupy more and more the whole extent of the murmur. After a little, indeed, the morbid sounds exceed the limit of the normal, and make these appear much increased in duration. And hence we ought not, in general, pronounce that there is an increase in the duration of a murmur, except when no considerable alteration of *quality* accompanies it.

When alterations of *quality* co-exist with other anormal sounds in the same period of respiration, they tend, by their greater intensity, and the more marked intonation with which they strike the ear, to obscure or even completely efface them. This is what occurs with respect to the hard and dry characters which accompany the respiratory sounds in the first period of phthisis: these characters can no longer be appreciated from the moment the bronchial *quality* appears.

The law that determines the coexistence of the bronchial character with expiration before it appears in inspiration, is the same for all cases where alterations of *quality* occur; if we find it difficult to apply this law in acute diseases, in pneumonia for example, it is that in these cases the phenomenon, running very rapidly through its earlier phases, arrives soon at such a degree, that it must, on the very principle I have laid down, coexist with both periods of respiration. But there is another mode of determining the accuracy of the principle, even in these very cases: that is, by investigating the different degrees of the phenomenon in different parts of the chest, instead of following its progress, the rapidity of which withdraws it from our observation. There was lately in St. Louis' ward, no. 18, a man in whom a pleuritic effusion formed gradually and slowly under my own eyes, in consequence of inflammation of the diaphragmatic portion of the left pleura: as the effusion increased, the bronchial character, feeble and preceded by the clear and blowing characters, appeared first in expiration and afterwards in inspiration: it then increased and soon occupied the whole period of these sounds. When the pleuritic effusion was fully formed, we ascertained, by percussion, that the sonorousness of the chest decreased from above downwards; it was scarcely altered above, obscure in the middle, and quite dull below. Now, above, no trace of bronchial character was audible; there was only a considerable diminution of the respiratory sounds; in the centre, some bronchial character in its first degree was mingled with expiration alone; and below, this character, at a much higher degree, occupied at once both periods of respiration.

The alterations of *quality* are more constant in their appearance, in their form, in their degree, and more independent of the mode in which the patient respires, in proportion as they have reached a higher degree.

3°. *The soft, smooth, continuous character.*

I have investigated with great care the alterations of the soft, free, mellowy character of the normal respiratory murmurs, in all the cases of auscultation I have met for some years, and I have learned to give to this class of signs more weight than is usually assigned to them. In emphysema of the lungs somewhat advanced, in the commencement of tubercular phthisis, in all chronic diseases of the lungs where sound portions are inclosed amongst indurated nuclei which impede their expansion, the inspiratory and expiratory murmurs, especially the first, instead of their soft, free, mellowy character, have a something *hard*, *rough*, and *restrained*, which is quite peculiar. The character of dryness most usually accompanies the preceding, and increases the morbid impression made by them. We sometimes meet the character of hardness and restraint during the resolution of a pleuritic effusion, when the liquid is nearly entirely absorbed: this character differs from the pleuritic friction sound. The value and the application of this sign being most striking in the diagnosis of the first stage of phthisis, I abstain for the present from giving with more detail its proper and differential characters. It is always more marked and more easily appreciable in inspiration than in expiration; it is less distinct in proportion as it coexists with a higher degree of bronchial character.

4°. *The dry or humid characters.*

The *dry* character, is seen in my observations, almost always coexisting with the *hard* character, in emphysema, in the first stage of phthisis, in all chronic indurations of the pulmonary tissue. The ear easily distinguishes the dry character, especially when the examination enables us to compare it with the humid. We find then a marked difference between the two, and between them and natural respiration.

In other circumstances the ear receives the distinct sensation of something moist. It seems as if the air passed across a tissue impregnated with fluid. Sometimes the impression is that of a watery fluid, for example, in œdema of the lungs somewhat advanced; sometimes, as in sanguineous congestion of the lungs, as in the period of the mucous secretion in acute pulmonary catarrh, we have the sensation of a fluid more viscid, more tenacious, and which seems to offer some obstruction to the free developement of the sound. The humid character I have described is analogous to that which I mentioned in speaking of my experiments with sponge. It differs from the humid ronchi in this, that instead of presenting the bubbling character more or less complete, which is the character of these ronchi, it is continuous in its production.

ARTICLE III.

MORBID CHARACTERS OF THE EXPIRATORY MURMUR.

I. *Alterations by augmentation.*

1st. The modifications of expiration are of great value in diagnosis; hence I will not hesitate to set them forth in detail. From 2, which represents its normal intensity and duration, expiration may rise to 20; its maximum of augmentation is therefore much greater than that of inspiration. Between 2 and 20 there are a great many degrees, which correspond sometimes to different diseases, sometimes to different periods of the same disease. In some affections, as for example phthisis and emphysema of the lungs, we may see the expiratory murmur pass successively through all its phases of increase.

2nd. It may be stated as a general fact, that the modification by augmentation of the expiratory murmur affects at the same time and equally its duration and its intensity. The few exceptions that I find in my notes, are cases in which the duration was increased, the intensity remaining normal. This circumstance might be a source of error, if we did not contemplate these two properties of the sound separately: the intensity being unchanged, and the mind having rather a tendency to attend to it, and neglect the duration, we might in such a case conclude that the expiratory murmur was natural or nearly so.

We must take care not to mistake for an absolute change in expiration what is no more than a change in the proportion between it and inspiration. It happens at times, that while expiration remains unchanged, inspiration is greatly diminished; accustomed to hear the inspiratory murmur much more developed than the expiratory, the ear is struck by finding the latter equal, or even superior to the former; and neglecting to appreciate the absolute condition of these sounds, it attributes sometimes to an increase in the expiration this change of proportion, produced entirely by the diminution of the inspiration. The fact to which I allude is by no means common: the error to which it exposes us may be avoided, by keeping in mind what are the absolute conditions of the intensity and duration of these sounds.

3rd. I have studied carefully, for some years, to ascertain in what circumstances the augmentation of the expiratory murmur is produced; the following are the results at which I have arrived.

It takes place under two different forms: in the 1° the normal ratio between the inspiratory and expiratory murmurs is maintained; in the 2° this ratio is destroyed. In the first case, the inspiratory sound has increased in the same proportion as the expiratory; in the second, the inspiratory murmur has remained in its normal state, or has even diminished, while a progressive elevation has taken place in the expiratory. Supplementary respiration is an example of the first; the second is seen in the first stage of phthisis and in emphysema of the lungs. The first is very common; it indicates an alteration in a part different from that in which those sounds are heard: the second, with which a much more serious prognosis is connected, is confined to a small number of circumstances, and for this reason is of considerable diagnostic value. The diagnostic value of augmentation of expiration with disturbance of the normal ratio between it and inspiration, increases in proportion to the degree of developement of the phenomenon: it is very great when the augmentation of expiration is considerable, and the inspiration is at the same time diminished; it is much less when the augmentation of the one is little marked, and the diminution of the other slight or inappreciable. Emphysema of the lungs and phthisis are the only affections in which increase of expiration with decrease of inspiration are met with in a high degree; and hence this double character has great diagnostic value in in those diseases. In its lower degrees, we may meet it in all indurations of the pulmonary tissue, in acute pulmonary catarrh, in pleurisy with moderate effusion. In phthisis and emphysema, it is only after passing through the inferior that it attains its higher degrees; but, with the exception of these two affections, it scarcely ever manifests itself in the latter form, unless indeed in chronic condensation of the pulmonary tissue, a condensation which is very analogous in its anatomical conditions to tubercular infiltration.

As in inspiration, the number that expresses the degree of increase of the expiratory murmur in general represents tolerably well the degree of anatomical alteration, and the successive increase of this number is a sufficiently exact expression of the successive aggravation of this alteration. The autopsy of persons who have died at different stages of phthisis has often enabled me to verify this fact.

In supplementary respiration the expiratory murmur usually increases in a greater proportion than the inspiratory; but still in all such cases it continues very different from that of emphysema and phthisis; for in the latter, inspiration instead of being increased is diminished; this diminution, it is true, is often confined to the duration alone. But besides, in the former, these morbid characters are always on the decrease, or at most remain stationary for some days, whilst in the latter, they go on continually increasing. I have never seen a case of emphysema of the lungs where the increase of expiration took a retrograde direction, and I have met only a few cases of phthisis, in which the expiration seemed, for a time at least, to return to its normal limits.

The augmentation of the expiratory murmur is easily simulated by the sound produced in the mouth, the pharynx, and the nasal cavities, during expiration; but with a little attention we soon find that this sound is produced in a region remote from the ear, that it can be heard at a distance, that the quality of the sound is somewhat more clear, somewhat metallic, and that the sound varies from time to time according to the manner in which the patient respires. On the contrary, that which depends on a real augmentation of expiration gives an impression of having originated immediately beneath the ear; it cannot be heard at a distance, it continues uniformly the same, and if its *quality* be altered, we find also an appreciable difference between the peculiar character of these alterations of *quality*, and the *quality* of the pharyngeal, buccal, or nasal sounds.

Certain anormal sounds may, in like manner, by their co-existence with expiration, simulate an increase of the duration and intensity of the expiratory murmur. Such are the sonorous and sibilant ronchi which accompany pulmonary catarrh. In emphysema of the lungs, the increase of expiration is independent of these sounds; but in simple catarrh (acute bronchitis), it is in general rather the result of this complication, than that it has a separate existence; I have however found that in some patients, who seemed to be affected with acute bronchitis alone, without any complication of emphysema or tubercles, the expiratory murmur was prolonged, at a time that no sonorous or sibilant ronchus was heard: but there is every reason to believe that this increase of the expiratory sound depended on supplementary respiration. I have said that the increase of expiration, accompanied with a change in the ratio between the two sounds, may also be met in the different indurations of the pulmonary tissue, and in pleurisy with moderate effusion; but, in these different affections, this anormal murmur does not exist constantly; we quite as often find that the expiratory murmur has undergone a diminution proportional to that of the inspiratory. So that, when the expiration is prolonged and augmented in intensity, it seems to me very important to determine its constancy. I have always found it constant in the first stage of phthisis, and in emphysema of the lungs. I have never, on autopsy, found tubercular infiltration of the tops of the lungs or emphysema, that the expiration during life had not been observed increased in intensity and d*uration;* and I have invariably found this morbid murmur continue permanent during the usual course of these diseases. They are the only ones in which it is met with this character of permanence; so that, while I admit that this sound may appear in other affections, I am of opinion that it has in those a peculiar diagnostic value. I will return to this subject in speaking of the differential diagnosis of the first stage of pulmonary phthisis (2nd part, chap. 17), and of exaggerated respiration (1st part, chap. 2, art. 8).

II. *Alterations by diminution.*

The degrees of diminution of the expiratory murmur are comprised between 2 and 0; below this there is complete cessation.

The diminution of the expiratory sound is much more rare than the diminution of the inspiratory, inasmuch as the circumstances which determine the latter must be carried to a much higher degree, in order to produce the former. Thus we often see inspiration reduced to 4 or 5, expiration remaining still at 2. But if, in this state of things, the pleuritic effusion increase, the expiratory number begins to decrease, and sinks to $1\frac{1}{2}$, 1, $\frac{1}{2}$, and even to 0. Its decrease is much more slow than that of inspiration; but they diminish in general in the same ratio: while one passes from 10 to 5, the other passes from 2 to 1; and so on. It may be said, in general, that the affections which diminish expiration leave the normal proportion in duration and intensity between it and inspiration unchanged; and that, on the contrary, those that increase expiration (except in the case of supplementary respiration) destroy that proportion: pneumonia, pleurisy with effusion, false membranes enveloping the lung, all considerable congestions of the pulmonary tissue, belong to the first class; emphysema and tuberculization of the lungs to the second. Now I remarked, in the general views with which I commenced this chapter, that every modification of the respiratory murmurs in which the normal proportion between them is destroyed, indicates an alteration of a more serious nature, of longer standing, leads to a more unfavourable prognosis, than those modifications in which the murmurs preserve their natural ratio: the proof of this is seen in the comparison I have just made between the affections that correspond to each of these cases.

The diminution of the expiratory murmur affects at once both the intensity and duration of this sound in a very large majority of cases.

All affections which produce a simultaneous and proportional diminution in the duration and intensity of inspiration, occasion also most frequently a diminution of expiration; whilst, on the contrary, when the intensity and duration of inspiration undergo opposite modifications, the one of increase, the other of diminution, the expiration is invariably increased. We have seen that there exist, in the normal murmurs, two ratios: one between the murmur of inspiration and the murmur of expiration; the other between the intensity and duration of each taken separately. Now the study of the morbid respiratory murmurs conducts us to this principle: *that these two ratios never separate, and that both are at once destroyed or preserved together.* In pneumonia, pleurisy, sanguineous congestion of the lungs, œdema of this organ, pulmonary apoplexy, there is diminution of inspiration and expiration, continuance of the proportion between these two, at the same time as between the intensity and duration of each of them. In emphysema and tuberculization of the lungs, expiration is increased, inspiration diminished, in respect to its duration, (the intensity very often continuing unchanged) and consequently the two proportions which I have just referred to are destroyed.

When resolution takes place in the affections that have produced diminution of both murmurs, expiration resumes its normal developement much more rapidly than inspiration.

III. *Alterations by cessation.*

The complete cessation of the expiratory murmur is very rare, still rarer than that of the inspiratory. It never takes place till after the latter. The type of this cessation of the expiratory sound is seen in pneumothorax.

IV. *Alterations by perversion.*

1°. *Rhythm.* The shortness of the expiratory murmur, its feeble intensity, the almost passive mechanism by which it is usually produced, scarcely allow us to assign it a determinate rhythm, and still less morbid modifications to this normal rhythm.

2°. *Quality (Timbre); soft, free character, &c.* But, on the other hand, the expiratory murmur presents in a more marked manner than the inspiratory, all the alterations of *quality* which I have before brought under notice. All that has been said in speaking of inspiration is *a fortiori* applicable here; for the alterations of *quality* first appear and are almost always more developed in expiration than in inspiration.

There are the same morbid characters, the same physical conditions of developement, the same course, the same modes of termination, the same successive gradations as in inspiration. The diseases that determine these alterations of *quality* are the same for both. Here, as in inspiration, we see the necessity of uniting under one common type all the alterations of *quality*, and of viewing them as so many gradually decreasing degrees of one phenomenon—variable, indeed, in its forms, but always the same in its nature.

Every alteration of *quality* is more marked and sooner developed in expiration than in inspiration. Every alteration of the free, smooth, continuous character appears first in inspiration, and assumes in it its most marked forms. These two classes of morbid phenomena are therefore directly opposed, in respect both to their earlier appearance and their greater developement, with one or other of the two periods of respiration. It is only when the expiratory murmur has undergone a striking increase in intensity and duration, that the characters of hardness, roughness, dryness become easily appreciable in it. Such is the case in the first stage of phthisis and in pulmonary emphysema. The humid character is in general but little marked in expiration, because most frequently the diseases that determine the production of this character, occasion at the same time a diminution of the expiratory murmur.

The modification by cessation is the most rare of all the changes that occur in the expiratory sound; the modifications by diminution come next; the modifications by augmentation are rather frequent; but those by perversion are the most common of all: a high degree of alteration by diminution, in general, indicates diseases very serious in degree, but not so in their nature*, as compared with those that correspond to alterations by perversion; the latter, indeed, for the most part†, suppose diseases of a serious nature. The alterations by diminution‡ are usually manifested over an extensive surface; it is the same, *a fortiori*, of those by cessation§. The other classes of modifications may indifferently, and according to the kind of case, appear over a very great or a very limited extent of surface.

The conditions of conductibility of sound of the organ itself in which the normal murmurs are produced, or of the organs around it, exercise a considerable influence on the degree, and sometimes even on the existence of the morbid sounds. Thus, great rarefaction of the pulmonary tissue, as in a high degree of emphysema, may greatly diminish or even altogether prevent certain morbid sounds from reaching the ear, which, where a recent disease comes to be engrafted on one of old standing, are produced at the centre of the organ. We had a fine example of this about two months ago at La Charité, ward of St. Martha, No. 6, in a woman emphysematous to the highest degree, who died of pneumonia.

ARTICLE IV.

CHANGE OF THE NORMAL RATIO BETWEEN INSPIRATION AND EXPIRATION.

Having considered the alterations by augmentation and diminution of the inspiratory and expiratory murmurs, as regards the absolute changes they produce in each separately, we must now view them with respect to the changes they occasion in those murmurs when compared together, that is, in the natural ratio that exists between them. We have already in many places remarked upon the importance, as diagnostic and prognostic signs, of the derangements of this ratio; the subject, however, deserves still further consideration.

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* Pneumonia, pleurisy, œdema, sanguineous congestion.

† Pulmonary emphysema and phthisis.

‡ Pleurisy with effusion; old false membranes; pneumonia.

§ Pleurisy with effusion; pneumothorax.

The inspiratory and expiratory murmurs are, as I have said, precisely similar in their fundamental characters; only, these characters are more marked in inspiration than in expiration; with respect to their intensity and duration, they are to each other as 2 : 10. This relation may be altered in two ways, to each of which I have directed attention at page 62: on the one hand, the intensity and duration of each, which in the normal state are expressed by the same number, may in the morbid state be represented by different numbers; on the other hand the ratio of 2 : 10 between the murmurs may be changed. The two sounds, at first identical in their nature, may become quite distinct in that respect. Thus, in the first stage of phthisis, we see at the same time: 1° a low degree of bronchial character appear in expiration, when there is not as yet any trace of it in inspiration; 2° the inspiratory murmur diminished in duration at the same time that it is sometimes increased in intensity; 3° the expiratory elevated from 2 to 10, and the inspiratory depressed from 10 to 2 or 4. In this last case it is obvious, that in respect to their intensity and duration the respiratory murmurs are in a state directly the reverse of their normal condition; but this change may go even farther, for the expiratory murmur may rise to 20, and the inspiratory sink even to 1. In extreme cases of emphysema of the lungs, I have often with a watch ascertained, that while the whole of the respiratory sounds and movements occupied 5 or 6 seconds, the period and murmur of inspiration consumed but 1, the other 4 or 5 being expended in expiration. But this morbid proportion between the duration of the two murmurs is only met in extreme degrees of emphysema.

It seldom happens that important changes take place in one murmur, without the other feeling them, and undergoing some kind or other of modification. In this point of view I find, from an accurate examination of all the facts I have collected, that changes in expiration much more rarely occur alone, and hence are more serious than those in inspiration. Whenever alterations in *quality* or noisy ronchi are present, the appreciation of the ratio between the murmurs is rendered much more difficult and sometimes impossible, at least with accuracy: this happens, for example in pulmonary emphysema complicated with catarrh, in phthisis when passing from its earliest stage to one more advanced. Then we lose the diagnostic advantage this appreciation supplies, but the sign is replaced by those that mask it.

In pleurisy and pleurodynia, we often find, as I have said, inspiration short, abrupt, jerking, convulsive, whilst expiration remains nearly normal. The same may occur with respect to the hard, dry, humid characters. In the earliest periods of tuberculization of the lungs it is

Of the modifications by perversion, those that affect the *quality* of the sounds belong especially to expiration; those that affect the soft, free, continuous character, and the dry or humid character, are more frequent, more marked, and more constant in inspiration.

The modifications by diminution of inspiration are usually in the same subject, and the same disease, proportional to those of expiration.

Those of increase are never proportional in the two periods, except in supplemental respiration.

The modifications by perversion are scarcely ever proportional.

Alterations by diminution and cessation, common to the two periods of respiration, always appear first, and advance more rapidly in inspiration than in expiration; in the return to the normal state, the expiratory on the contrary precedes the inspiratory murmur*. When both sounds have at the same time suffered modifications by increase or diminution, the modification by increase is always carried farther in expiration than in inspiration†; that by diminution on the contrary, is carried farther in inspiration than in expiration‡.

Inspiration, as we have already said, precedes expiration in the modifications by diminution; on the other hand, in the modifications by increase, expiration precedes inspiration§.

Expiration may continue almost unaffected, while extreme diminution takes place in inspiration‖, and this in like manner remain unchanged while expiration has undergone considerable increase¶.

In another respect also, we may have inspiration and expiration in opposition: when the alteration in the first is chiefly a diminution of its duration, the alteration in the other is chiefly an increase of the same character; we observe this in emphysema and the first stage of phthisis.

In conclusion, the inspiratory and expiratory murmurs, considered separately, present, in their modifications, most important means of diagnosis, signs of precise physical value, regulated by laws nearly constant and easily appreciated. The signs furnished by inspiration belong in general more to diagnostics already known. Those that expiration furnishes, on the other hand, belong rather to affections the diagnosis of which has been hitherto very difficult**; or to circumstances more or less obscure belonging to diseases in other respects easily recognised; their application applies particularly to the differential diagnosis of different affections.

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* We observe these facts plainly in pleuritic effusion which forms under our own eyes; which becomes so abundant that the bronchial character ceases to be audible, and which is afterwards gradually resolved.

† For example, supplementary respiration.

‡ For example, chronic congestions, pleurisy, &c.

§ Supplementary respiration, first stage of phthisis.

‖ In certain cases of pleurisy, of pneumonia, of chronic congestions of the lungs.

¶ In certain cases of emphysema, and of the first stage of phthisis.

** First stage of phthisis.

chiefly the inspiration that is hard, rough, crumpling. However, in some cases, where the lungs were found covered with thick, false membranes, the hard, rough character had been most marked in expiration. The humid character which accompanies active sanguineous and serous congestion of the lungs is more marked in inspiration than in expiration. The general fact that results from the preceding considerations is this: *the prognosis derived from the disturbance of the normal ratio between inspiration and expiration is more serious, in proportion as this disturbance affects a greater number of the relations I have pointed out.*

ARTICLE V.

PARALLEL BETWEEN THE MORBID CHARACTERS OF THE INSPIRATORY AND EXPIRATORY MURMURS.

The morbid modifications of inspiration are more frequent than those of expiration. They are in general more easily appreciated with accuracy on account of the greater intensity and duration of the inspiratory murmur. But when expiration has undergone any considerable augmentation, its morbid modifications are as easily appreciated as those of inspiration,

A more serious prognosis is connected with the diminution of the expiratory murmur, than with a proportional diminution of the inspiratory.

On the contrary, alterations of *quality* in the inspiratory sound indicate a more serious prognosis than the same changes in the expiratory; because such alterations, in their natural course, appear first in expiration, and only extend to inspiration, when the organic change has made farther progress. In general each is of equal value in prognosis, when the modifications of *quality* in expiration are just a shade higher than in inspiration.

The intensity and duration of the sound are scarcely ever separately affected in expiration; in inspiration they are often modified in opposite directions.

The most frequent and important signs furnished by inspiration are derived from its modifications by diminution, and those furnished by expiration from its modifications by augmentation, (putting out of consideration for the present those of perversion).

In both periods of respiration, modifications by perversion indicate a more severe form of disease than the other modifications; taking, among the latter, those that correspond to the most serious maladies, for example the augmentation of the expiratory sound*, the signs derived from the modifications by perversion denote a still higher degree of these same diseases; they hold, therefore, the first place among the morbid sounds, as well as signs of the degree, as of the nature of the organic alterations.

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* Emphysema of the lungs; first stage of phthisis.

Of the modifications by perversion, those that affect the *quality* of the sounds belong especially to expiration; those that affect the soft, free, continuous character, and the dry or humid character, are more frequent, more marked, and more constant in inspiration.

The modifications by diminution of inspiration are usually in the same subject, and the same disease, proportional to those of expiration.

Those of increase are never proportional in the two periods, except in supplemental respiration.

The modifications by perversion are scarcely ever proportional.

Alterations by diminution and cessation, common to the two periods of respiration, always appear first, and advance more rapidly in inspiration than in expiration; in the return to the normal state, the expiratory on the contrary precedes the inspiratory murmur*. When both sounds have at the same time suffered modifications by increase or diminution, the modification by increase is always carried farther in expiration than in inspiration†; that by diminution on the contrary, is carried farther in inspiration than in expiration‡.

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Expiration may continue almost unaffected, while extreme diminution takes place in inspiration‖, and this in like manner remain unchanged while expiration has undergone considerable increase¶.

In another respect also, we may have inspiration and expiration in opposition: when the alteration in the first is chiefly a diminution of its duration, the alteration in the other is chiefly an increase of the same character; we observe this in emphysema and the first stage of phthisis.

In conclusion, the inspiratory and expiratory murmurs, considered separately, present, in their modifications, most important means of diagnosis, signs of precise physical value, regulated by laws nearly constant and easily appreciated. The signs furnished by inspiration belong in general more to diagnostics already known. Those that expiration furnishes, on the other hand, belong rather to affections the diagnosis of which has been hitherto very difficult**; or to circumstances more or less obscure belonging to diseases in other respects easily recognised; their application applies particularly to the differential diagnosis of different affections.

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* We observe these facts plainly in pleuritic effusion which forms under our own eyes; which becomes so abundant that the bronchial character ceases to be audible, and which is afterwards gradually resolved.

† For example, supplementary respiration.

‡ For example, chronic congestions, pleurisy, &c.

§ Supplementary respiration, first stage of phthisis.

‖ In certain cases of pleurisy, of pneumonia, of chronic congestions of the lungs.

¶ In certain cases of emphysema, and of the first stage of phthisis.

** First stage of phthisis.

ARTICLE VI.

RELATIONS, PHYSIOLOGICAL AND MORBID, BETWEEN THE RESPIRATORY MURMURS AND MOVEMENTS.

I have made researches, some physiological, others clinical, others manometric, with a view of determining: 1° the relations physiological and morbid that exist between the respiratory murmurs and movements; 2° the degree of suction force, and of pressure expended in the accomplishment of inspiration, of expiration, and of each of the respiratory acts that depend on them; 3° for the purpose of investigating some of the conditions of production of the vibratory motions of the chest. These researches are very far from explaining every thing connected with each of these questions: my object was only to throw light upon some points; and among the results obtained I shall select those that have been most invariable. Some are applicable to semeiology, others to the mechanism of production of the physiological and morbid sounds of the respiratory apparatus.

1st. *Physiological experiments.*

December 13th, 1836, I made, with M. Piorry, some experiments on living animals, in reference to the operation for empyema, with which at that time the Academy was very much occupied. We availed ourselves of this opportunity to examine the locomotive movements executed by the lungs during inspiration and expiration.

A strong vigorous rabbit of moderate size was fixed upon its back; an incision made down the centre of the sternum, and the skin of the thoracic regions rapidly dissected and thrown aside. The pectoral muscles being raised, so that the walls of the chest were now formed by the ribs and intercostal muscles alone, we could see what passed in the chest: a white body successively ascended and descended, as if by a movement of expansion and contraction: it was the lung; we endeavoured carefully to analyse its motions.

The respiration of the animal was calm; it did not appear to be affected by the operation.

Inspiration.—During inspiration the walls of the chest receded from their central axis; the thoracic cavity was enlarged in every direction; and at the same instant, as if under the same dilating influence, the entire mass of the lung underwent a general movement of expansion; its tissue became turgid, the border of its base, and its anterior edge swelled up and executed an actual locomotive movement. During this locomotion, the surface of the lung rubbed against the pleura, and the border of the base of the organ was transferred at least ½ an inch (in ordinary respiration) beyond the point where it stood at the commencement of inspiration.

The movement produced by this expansion was brief, rapid, very *regular*, but successive, notwithstanding its rapidity: it was particularly easy and free from effort; it was always the same, at most only varied by the degree of expansion.

The gliding or friction of the two serous surfaces upon each other produced no sound: we satisfied ourselves of this by auscultation.

It seemed to us, in this experiment, that the lung followed (but followed at once, without any interval) the expansion of the walls of the chest, and the retreat of the abdominal organs, rather than that it had the power of determining by its own expansion this recession of the thoracic walls from their central axis. These two movements were simultaneous, and as if produced at once by the same cause.

Expiration.—The movement of retreat, that is, expiration, succeeded without any obvious interval the movement of expansion. We saw the lung sink in, lose its turgescence, and return upon itself with an elasticity which was free, smooth, rapid, regular and successive, without any jerking. We saw it return to the point from which it had set out at the commencement of inspiration, by a movement resulting from its sinking in, and a locomotion in the opposite direction to the former. There was again friction between the surface of the lung and the costal pleura, during this period, but friction without noise as before.

We repeated the experiment on another rabbit, having reduced the thoracic walls to the smallest possible thickness, in order to render them still more transparent. It was in this case even more easy to analyse the the alternate movements of expansion and contraction of the lungs. The phenomena were the same; except that an opening having been made into the chest on one side, and the animal being almost in a state of asphyxia, the dilatation of the chest and of the lungs was greater, and the expansive locomotion of the border of the base was at least an inch instead of half an inch. Notwithstanding this greater expansion, this more extended friction between the two serous surfaces, auscultation still gave only a negative result.

Thus, 1°, expansion with locomotion of the lung during inspiration, contraction with locomotion of it during expiration; 2°, a direct ratio between the degree of this locomotion and the degree of difficulty of breathing; 3°, a direct ratio between the extent of the thoracic movements, and the extent of pulmonary locomotion; 4°, in all cases, noiseless gliding of the two serous surfaces upon each other in the normal state. The duration and intensity of the respiratory murmurs, increase directly as the frequency and the difficulty of respiration. It appears already, as a consequence of these facts, that there is a direct ratio between the intensity and duration of the respiratory murmurs, and the extent of the pulmonary or thoracic movements.

2nd. *Clinical experiments.*

In fact, if we take a number of healthy persons, well formed, and with well developed chests, and make them respire sometimes more, sometimes less forcibly, we observe in general that the intensity and duration of the respiratory murmurs correspond to the extent and frequency of the thoracic movements. Now, as we have just demonstrated, that the latter are always directly proportional to the extent of pulmonary locomotion, we may infer that in man, as in animals, the degree of expansion and locomotion of the lungs may be very well estimated from the different degrees of intensity and duration of the respiratory murmurs. Indeed, pathological anatomy and symptomatology teach us that diminution of the respiratory murmurs corresponds to organic alterations of such a nature[*], that the lung no longer yields so easily to the expansion produced by the penetration of air into its cells. In supplementary or exaggerated respiration, the intensity and duration of the murmurs are increased; now, this supplementary respiration which we produced in the animal that served for our second experiment, corresponds, as we have seen, to an exaggeration of the pulmonary and thoracic movements. In general, we may say, that there exists between these three facts—1°, the intensity and duration of the respiratory murmurs; 2°, the frequency and extent of the thoracic movements; 3°, the degree of the expansive and locomotive force of the lung—so intimate a connexion, that the derangements of one, necessarily re-act on the others, and hence, that we may, from those derangements that can be seen or heard, appreciate those that cannot be directly observed during the patient's life. Hence it is, that the thousand varieties that constitute the morbid sounds of respiration, and the modifications produced in the thoracic movements, can guide us to a knowledge of the smallest organic alterations that occur in the lung.

But the connexion between these three facts is far from being so general and so absolute in pathology as in physiology. It is true we usually find the three diminish together[†], or increase together[‡], and this in the same proportion; but sometimes they cease to correspond, they separate from each other, are decomposed and combined in various ways.

Thus with great diminution of the expansion of the lung, and of the duration and intensity of the normal murmurs, we sometimes have the thoracic movements exaggerated and as it were convulsive; for example: in all cases where there is a mechanical obstacle to the penetration of air into the bronchial system, whether from thickening of the mucous membrane or from any other cause; for example: in certain nervous affections of the respiratory organs (nervous asthma), in which, notwithstanding the convulsive efforts made by the patient, the air appears not to reach the air cells at all; in such cases, in fact, the respiratory murmurs are either no longer audible or are very feeble indeed.

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[*] Such are most of the organic diseases of the pleura, lungs, bronchi, trachea and larynx. For example, in cases of contraction of the larynx, or of the trachea, or in cases of congestion of the lung, we can very well judge of the degree of laryngeal contraction or of pulmonary congestion, from the degree of diminution of the respiratory sounds. This means of investigation sometimes furnishes precious data for prognosis and for treatment.

[†] In pleurisy with effusion, in pneumothorax, in cases of very old and very thick false membranes surrounding a lung, in acute or chronic hepatization of a great part of the mass of one lung, in tuberculization of the summits of those organs, &c. the intensity and duration of the inspiratory and sometimes of the expiratory murmurs are much diminished, as well as the thoracic movements and the expansion of the lung.

[‡] For example, exaggerated respiration.

Thus it is that the thoracic and pulmonary movements having diminished, the two respiratory murmurs, instead of diminishing also, according to the general law, separate from each other, in such a way that one only is diminished, and the other on the contrary is increased. This is what we see in phthisis pulmonalis and in emphysema, where the inspiratory murmur is diminished and the expiratory increased. Thus it is that, in numerous cases, the thoracic movements like the sounds are decomposed; that the inspiratory movement is diminished and the expiratory increased. Such is the case in pulmonary emphysema. I have already said that in patients affected with emphysema in an intense degree, we can easily determine, with the aid of a watch, that the duration of the inspiratory movement is to that of the expiratory as 1 to 4 or 5.

Thus it is that in the first stage of phthisis pulmonalis, &c. we find diminution of the pulmonary expansion and of the inspiratory murmurs, coinciding with diminution of the partial movements of the chest; the movements of the whole continuing nearly unchanged. The whole thoracic cage continues to rise and fall as one entire piece, but the movements by which the ribs are approximated and separated have become much less marked.

In the midst of these apparent deviations from the general principle that connects and governs the three facts 1°, the extent and force of the thoracic movements, 2°, the locomotive expansion of the lung, 3°, the duration and intensity of the respiratory murmurs, we can still discover between these irregularities and the anatomical fact on which they depend, relations that bring them more or less under our principle; thus: 1°, in pulmonary emphysema and the first stage of tuberculization of the lungs, we see the two periods of the respiratory murmurs, as well as the two periods of the thoracic movements, undergo alterations in opposite directions, so that one of the periods is increased and the other diminished; but there is this correspondence between the murmurs and the movements, that the alterations in each are the same; inspiration is diminished and expiration increased. The same changes take place in the pulmonary movements: in fact if we open the chests of broken-winded horses we see the movement of contraction or the retreat of their lungs much more slow and more prolonged than the movement of dilatation, which has become extremely feeble. 2°. The perfect harmony between these three circumstances, motions of the chest, motions of the lungs, duration and intensity of the respiratory murmurs, does not exist, and in fact cannot exist, except when the alteration that has taken place in the lung is of such a nature as to act upon the three facts in the same manner and nearly to the same extent; thus, in considerable pleuritic effusion, in pneumo-thorax, in hepatization of the entire mass of a lung, the walls of the chest resisted from within by the effused liquid or air, or by the solid body into which the lung is converted, cannot easily move and scarcely present any trace of their partial motions; the air no longer penetrating into the pulmonary tissue, the motions and sounds of the lung are no longer produced or are produced but imperfectly. 3°. If on the other hand, the thoracic movements continue or are exaggerated, notwithstanding the diminution of the murmurs and apparently of the motions of the lung, it is that the cause which determines these disorders is of a nature to act on the one and not on the others; such as thickening of the bronchial mucous membrane, any kind of narrowing of the air tubes, that prevents or impedes the passage of the air, and consequently the murmurs and movements of the lungs, without obstructing the movements of the chest. Thus, by keeping in view all the elements of the question, we may usually ascend from the effect to the cause; and so this accidental disagreement between two phenomena usually connected together by similar characters, (the intensity and duration of the respiratory sounds, the force and the extent of the thoracic movements) instead of the confusion it at first seems to produce, is on the contrary calculated to afford us aid in the analysis and accurate appreciation of the facts. If we would always take pains to examine attentively the different questions involved in a diagnosis, and determine the relations of the facts with each other, we should certainly meet with much fewer cases that we could not master. 4°. The movements of the whole chest resisting longer than the partial movements a common obstacle, if the first continue and that the second have ceased or at least greatly diminished, we will have reason to think that the physical cause that determines this alteration is less than if the movements of the entire and the partial movements had both ceased. In fact, in the latter case, we have to do with a very abundant effusion of air or liquid in the pleura, or a very thick fibro-cartilaginous false membrane, which binds down the lung in its whole extent; in the first case on the contrary, we have the same affections, but in a less severe degree, or perhaps moderate emphysema, or tuberculization of the top of the lungs.

We may distinguish in the movements of the chest as in the respiratory murmurs, the intensity or the force, the duration or the extent. The movements, like the murmurs, may be altered in these two qualities at the same time, or in one alone, or in each in a different way. In pneumothorax, the motions of one side are diminished, of the other almost abolished, in the twofold relation of force and of extent. In pneumonia of an entire lung, in recent pleurisy with moderate effusion, they are diminished in extent only, and sometimes increased in intensity. In emphysema of the lungs, the movement of expiration is greatly increased in duration and diminished in intensity. The partial movements are sometimes greatly diminished, whilst the movements of the whole remain unchanged or still more frequently are augmented. This occurs whenever adhesions between the lung and pleura, a moderate effusion, tubercular or other indurations of the tops of the lungs, produce considerable dyspnea, at the same time that they present but a slight physical obstacle to the thoracic movements.

It is very rare to find the movements of the whole chest cease entirely under the influence of an affection of the pleura, and I do not think that any affection of the lungs is capable of producing this effect. In a patient in the ward St. Louis, (hospital de la Charite,) in whom we found a dilatation of nearly 2 inches of the right side of the chest, produced by an abundant pleuritic effusion, the motions of the entire of this side of the chest were still very obvious, and yet this was one of the most considerable dilatations that has been met with; there was scarcely any trace of the partial movements.

The alterations of the duration and intensity of the respiratory murmurs, are the only ones that are connected with the alterations of the thoracic movements by any very evident relation; besides I should remark that it is only when they have attained a somewhat elevated degree and when the conditions of their production are constant, that these alterations and the alterations of the thoracic movements are connected together by rather intimate relations. Apart from these two conditions, mere nervous influence is sufficient to disturb the thoracic movements, without any sensible modifications being produced in the murmurs, or without these modifications, if they exist, corresponding to any organic alteration in the lungs. But, in this case, the modifications suffered by the thoracic movements, affect the rhythm rather than the duration and force of these movements. Besides, it seldom happens that the morbid relations, which we have pointed out between the respiratory murmurs and movements, are so closely simulated by mere nervous disturbance, that there is any danger of mistaking them. This mistake is the more difficult, as the nervous influence can only modify the respiratory murmurs in their rhythm, their duration and their intensity, whereas the majority of alterations of the pleura, and of the lungs, produce other alterations in them by which they can be recognized.

In immediate auscultation, the ear applied to the chest, feels the thoracic movements at the same time that it hears the thoracic sounds. Sometimes too, if we are not careful, it happens that these two sensations are confounded into a single one, that we appreciate only the movements, (more particularly when the sounds are diminished), that we refer this sensation produced by touch to the auditory sensation which usually occupies us, and that we call that sound which is only motion. I have often seen persons tolerably practised in auscultation confound thus, in a moment of inattention, these two things together, and affirm that the respiratory murmurs were unchanged, while, in reality, they were greatly diminished.

3rd. *Manometric experiments.*

A favourable opportunity occurred lately for making manometric experiments on respiration. I had performed tracheotomy on a young girl in M. Andral's wards, who had had for more than 4 years a very severe affection of the larynx*. At the time I operated, the patient's voice was quite extinct, she was reduced to a state of complete marasmus, and asphyxia was impending. M. Andral had the kindness to leave the management of the case to me. Under the influence of the local† and general treatment which I adopted, she gradually regained flesh, her general health became very good, and her voice and respiration returned nearly to their natural state. At this time she still wore the canula; I had taken the precaution of leaving it in its place, plugging it up at the same time with linen, in order that respiration should go on entirely through the larynx‡. Things were in this state about a year when I commenced some manometric experiments on the patient.

The nature of the manometer of M. Cagniard Latour is well known. This able experimenter has contrived two instruments. One consists of a column of mercury, intended to measure strong pressures: it is composed of a bent glass tube, the two branches of which are parallel. Both branches are left open, and the mercury introduced into the tube being exposed in each to the same atmospheric pressure, stands at the same height in both. One of these branches being adapted to the opening in the trachea, the column of mercury it contains ascends during inspiration, on account of the vacuum that is produced there; and descends during expiration, on account of the pressure that takes place: and as the tube is graduated, we measure in this way the degree of force of inspiration and of expiration. The other manometer is a column of water, and consists of a tube of large diameter rounded at one extremity, open at the other, and about half filled with distilled water. A capillary tube is plunged into the water contained in the large tube; the water reaches the same level in both, but ascends a little higher in the smaller, on account of its capillary form: a small column of water is thus constituted, which rises or falls according as inspiration or expiration acts on the smaller tube, which is adapted to the opening of the trachea. A graduated scale on the tube, as in the former case, enables one to appreciate the different degrees of pressure to which the small column of water is subjected.

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* This appeared to be (such was also the opinion of M. Andral) a chronic induration of the submucous cellular tissue of the larynx. We ascertained, by catheterism, a very considerable contraction of this canal.

† The local treatment consisted chiefly in injections of a caustic liquid, which was thrown directly into the larynx, through the fistulous opening in the trachea, by means of a small glass apparatus made for the purpose.

‡ Since these experiments were made, the canula has been removed, and the fistulous opening of the trachea obliterated. Although it had existed more than two years, simple suture of the pared edges of the fistula sufficed to close it perfectly. I exhibited *this patient to* the Academy of Medicine before and after the obliteration.

This instrument, though very ingenious, would not answer for the object I had in view; accordingly it was necessary to modify it. The patient could not inhale enough of air for an inspiration in either of the above manometers; consequently this could not be effected in the normal conditions, and the result must necessarily be erroneous. This instrument, at most, could only serve to measure the pressure of expiration, the patient inspiring by the mouth and expiring by the tube. These inconveniences were avoided by placing on the tube by which the manometer communicates with the trachea, a large reservoir of air, from which the patient could draw air for several inspirations. This reservoir was a large glass globe, with several tubular openings, which enabled us during the experiment to renew the air vitiated by the respiration of the patient. By making the manometer very long, I have been able in general to do without the mercurial instrument. I received much assistance in these experiments from one of my friends, an able man, M. Gavaret, educated at the Polytechnic School. Some other manometric experiments, of which I will make little use here, were made with M. Cagniard Latour, who has given an abstract of them in the Journal of the Institute.* It would be much too long to go into a detail of all the observations I made on this subject; I will confine myself here to an account of the results verified by the members of the Academy who were appointed to witness my experiments. I have described the apparatus I used, in order that others may repeat or follow up these manometric researches. I should observe that they require great care, for slight differences in the mode of proceeding may vary the results. We must take care that all the joints of the apparatus are hermetically closed; we must be sure that the air does not escape at the point of junction of the tube with the trachea. The presence of the canula does not sensibly change the results, however it is better to omit it; the best mode is to use an œsophagean catheter, as a tube of communication between the patient and the apparatus, the expanded end resting on the neck and receiving into it the fistulous opening. When we wish to compare together the results of some experiments, it is important that the patient observe exactly the same conditions in the different cases we compare. We ought in the results to take into account, 1°, the influence of the capillary form of the manometric tube; 2°, the influence of gravity on the degree of depression of the column of water, suspended for an instant above its level by the force of inspiration, then abandoned to itself and pushed down by the expiration that succeeds: the capillary influence varies with the diameter of the small tube; with respect to the influence of gravity, when the manometric column has been raised by ins ration 20 centimeters above its level, it falls by the mere influence of gravity one centimeter below this level. So that this influence is nearly one in 20, or $\frac{1}{2}$ in 10.

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* Journal de l'Institut, Decembre 1837, no. 222, et Janvier 1838, no. 223.

1st. When the patient breathed by the mouth and nose at the same time as by the manometric tube, the influence of pressure on the manometric column diminished, though it remained proportional to the stronger influence that was exerted when the patient breathed by the apparatus alone. The result here is quite simple, as in the one case the respiratory power was concentrated on the atmosphere of the apparatus, and that in the other, a part of this power was lost on the exterior atmosphere.

2nd. If we made the patient breathe so as to give the respiratory sounds the buccal, pharyngeal, nasal character, the manometric results remained the same as in ordinary respiration; from which we may infer that no greater expenditure of force is required for the production of this kind of respiration.

3rd. With the water manometer modified in the manner I have described, the mean force of suction in inspiration was 10 centimeters, and that of pressure in expiration was 5 centimeters. We see from this that the ratio between inspiration and expiration, considered as moving forces, is not the same as between inspiration and expiration considered as sounds; and that in expiration particularly, there is less sound produced than force expended, in comparison with inspiration: on the one hand, the ratio of 10 : 2; on the other, of 10 : 5. This difference may depend on the different mechanism of production of inspiration and expiration, or perhaps on the number of expiration being too small in our approximative value of the ratio between the inspiratory and expiratory murmurs; but as an *absolutely* accurate value of this ratio is of little importance in practice and as besides it would be probably very difficult to obtain, I pass it by. It is enough that clinical and anatomico-pathological facts agree in the ratio of 10 to 2 for the inspiratory and expiratory murmurs, to make it more advantageous to adhere to it in practice.

4th. *a.* In sighing, the manometric influence of inspiration increased a centimeter, that of expiration remaining the same.

b. In speaking in a low tone, the pressure was the same as in ordinary respiration. In proportion as the voice rose in intensity, the depression of the column of liquid increased. It was eight centimeters below its level in the ordinary high voice, and 22 in a loud shout.

c. The pressure was a little stronger in continuous, than in broken speech.

d. It was much stronger, other things being the same, in the acute than in the grave tones.

e. In ordinary speaking, the pressure on the manometric column was *from* 14 *to* 16 centimeters.

f. In efforts, as at stool, the column fell so much as 56 centimeters.

g. In sneezing, the pressure was much greater still, and represented the maximum of power of the expiratory forces.

i. In ordinary cough, the pressure was 40 centimeters; in more violent coughing, the pressure was as much as 55 to 60 centimeters.

Several consequences follow from these results:—1°, the force expended in the expiratory acts is much greater than that expended in the inspiratory*; 2°, the expiratory acts exhibit numerous differences in this respect; and if the fatigue the patient suffers from them is proportioned, as we have a right to think it is, to the quantity of force expended, we may conclude that speaking in a low voice is not more fatiguing to him than ordinary respiration; that the fatigue increases in speaking in the direct ratio of the intensity, in the direct ratio of the continuity, and in the direct ratio of the acuteness of the tone of the voice. 3°. All the expiratory acts which are produced with a convulsive character, as efforts, coughing, sneezing, produce an expenditure of force, and consequently a degree of fatigue, much more considerable than those that have not this character. Sneezing, which is the type of the convulsive character, is of all the expiratory acts that which requires the greatest expenditure of force. Every one has experienced in himself these different modes and different degrees of expiration; now, if we recal the sensation felt in each, we will find our impressions correspond exactly with the manometric results I have detailed. In general, indeed, our impressions are accurate, but they cannot receive the stamp of truth, unless they have the sanction of observation or direct experiment. 4°. We have a mode of making the patient inspire or expire more or less strongly, when this is requisite for some auscultatory result, by making him perform some one of these inspiratory or expiratory acts which we have been just considering. 5°. In pathology, as in physiology, there is greater expenditure of force in the production of acute than of grave tones: we know that the whistling and sibilant ronchi are produced particularly when the diameter of the bronchial tubes is diminished by the tumefaction of their mucous membrane: we know that laryngeal inspiration and expiration are more whistling in proportion as this portion of the respiratory passages is more contracted; we know also that in these diseases the patients' respiration is effected with greater effort: and that the anormal sounds of the heart assume more and more of the acute tone, (bruit de scie, de *sibilus* musical,) as the contraction of the orifices is greater. We may also lay down as a general principle, that the anormal sounds indicate a more serious prognosis, in proportion as they present a higher degree of the acute tone; there are exceptions, however, to this rule. 6°. It appears, from the account of our experiments, that in the different respiratory acts, the lungs, the trachea, and the larynx support a much greater degree of pressure than is generally supposed, inasmuc as this pressure has exceeded, in some cases, the ordinary pressure upon them, by nearly the weight of the atmosphere. Yet the patient did not suffer any inconvenience, not even fatigue, because our experiments were continued but a short time on each occasion. If we compare these results with those furnished by clinical observation, the consequence that presents itself is, that the respiratory organs, such as the lungs, the trachea, and the larynx, can bear with impunity very strong pressure when it is but momentary; that it requires an enormous pressure to rupture any of them; whereas a much slighter, but continuous and prolonged pressure, may soon produce mischievous effects, if it exceed a little the normal limit. Such is pulmonary emphysema, which cannot be produced instantaneously by the greatest efforts made by workmen who raise heavy weights*, and which comes on gradually from repeated attacks of bronchitis†. 7°. I think with M. Cagniard Latour‡ that the fatigue felt by players on reed instruments is partly owing to this, that the pressure they support during their efforts of insufflation, falls not only on the lungs, the trachea, and the larynx, which are organised to sustain considerable pressure, but also on organs, such as the walls of the mouth, &c. which are neither habituated nor destined to support it. 8°. The great pressure, which the trachea and the larynx are capable of sustaining, is favourable to the opinion that assimilates the voice to the sound of a reed instrument rather than to that of a flute. M. Magendie, to whom these results were submitted, has made use of them in support of his theory§. M. Cagniard Latour has taken some pains to develope this idea and has communicated his views to the Philomathic Society‖.

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* It is obvious that I put out of view here ordinary inspiration and expiration.

5th. In general, there is a correspondence between the expiration and the inspiration that preceded it, as well as between the expiration and the following inspiration: if one has been produced above the normal limit, the other feels its influence. It is only by an effort that we can produce a normal expiration immediately after a very strong inspiration, and vice versa. This principle holds at once in the murmurs, the thoracic movements, and the manometric results. Hence it is, that panting, however accidental it may be, cannot cease abruptly; the respiration must go through successive, and more or less rapid periods of decrease. So, when we make a patient take a deep inspiration which augments the murmur, we are sure (unless the patient hold his breath) to find the succeeding expiratory murmur increased.

* Traumatic emphysema of the lungs is only produced, in general, by very violent pressure, as a blow of the shaft of a waggon, a heavy body striking the sides, violent insufflation of air into the chest, &c.

† I do not mean to deny that, in these cases, a predisposition to the developement of pulmonary emphysema exists, but the occasional cause is still what I have pointed out; at least every thing leads us to think so.

‡ L'Institute, 6 annee, Janvier, 1838, no. 223.

§ Communication made by M. Cagniard Latour.

‖ Journal de l'Institut, 6 annee, Janvier, 1838, no. 223.

6th. If we observe the rhythm according to which the manometric movements are produced, when respiration is regular, we find that these movements, like the murmurs with which they correspond, are nearly continuous, and not at all jerking in their formation. There is a pause between the expiration and the inspiration, that is, between two complete respiratory movements; but we cannot observe any very sensible interval between the inspiration and the expiration of the same respiratory movement. In certain affections however, where inspiration is very difficult, as in emphysema of the lungs, and some diseases of the larynx, a short pause occurs between the inspiration and the expiration of each respiratory movement. In the determination of this last result, and some others that I am about to state, I submitted to manometric experiments, persons affected with different diseases of the respiratory apparatus. For this purpose I adapted to the tube of the manometer a glass funnel, which was placed over the openings of the mouth and nose of the patient. It was arranged so that no air could escape. I have in the same manner experimented upon healthy persons. It is from a comparison of these different results, that the general facts that precede and follow here have been derived.

7th. If the chest of a person submitted to manometric experiments, be strongly compressed, the column does not rise as high as usual in inspiration, but falls as usual in expiration. Hence we are authorized to lay down this principle: that the obstruction of the functions of the parietes of the chest, produces a diminution of the force of inspiration, without sensibly affecting the force of expiration. If, while an assistant observes the manometric movements, we auscultate the chest of the person experimented on, the result agrees entirely with what is observed in the manometer: the expiratory murmur continues normal, and the inspiratory is diminished. Have we not indeed remarked, that in cases of considerable pleuritic effusion, of pneumothorax, of old false membranes embracing the lung, the inspiratory murmur was much diminished, sometimes altogether extinct, while the expiratory murmur was little if at all affected; in these cases the obstruction of the function of the thoracic walls is produced by the disease instead of by artificial compression. It will be recollected that in our experiments with sponge (pages 15 and 16) we arrived at this principle, that the respiratory murmurs are directly proportional to the number of vesicles pervious to air, and to the degree of expansion of those vesicles; that the murmur increases or diminishes, with the increase or diminution of these two conditions. Now, the results of the experiment I have just related lead to the same conclusion. These results furthermore favour the opinion that the lung is passive in inspiration and active in expiration*. This difference between the mechanism of the two respiratory movements is one of the causes of the continuance of the expiratory murmur, in diseases that produce more or less diminution of the inspiratory.

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* This active power, moreover, may depend merely on the elasticity of the walls of the cells.

8th. In proportion as respiration assumes a more convulsive character, we find the manometric column rise higher and higher, during inspiration, whilst during expiration it does not fall below its normal limit. This fact is the reverse of the former. In this case the muscular power is pushed to its maximum of action, this power presides over inspiration peculiarly, and the latter is greatly augmented, both as regards the movement and the murmur; whilst the expiratory forces having scarcely suffered any change, the murmur and the movement of expiration are produced in their normal limits. In the preceding case, the inspiratory forces were restrained, the expiratory remaining unchanged; the inspiratory murmur and movement were diminished, the expiratory remained unaffected.

9th. In certain circumstances, however, where the inspiratory effort is convulsive, and where the air does not reach the air-cells at all, as in a high degree of emphysema, as in some asthmatic paroxysms, the murmurs and the manometric results may disagree; then, indeed, the inspiratory murmur is much diminished, though the influence of inspiration on the manometric column is much increased. This fact may be presented in the following form: the less deeply the air passes into the bronchial system, the more the manometric influence of inspiration is increased, and the more the inspiratory murmur is diminished. The reason is obvious. Except in this, and analogous cases, there is on the contrary, as we shall hereafter see, a direct correspondence between the murmurs, the thoracic movements and the manometric results.

If our experiments be made on a patient affected with considerable contraction of the larynx, or if indeed we observe what occurs when a person in health breathes through a very small opening of the mouth or nostrils, we recognize the preceding fact under a different form, and we arrive at the following principle: the manometric influence of expiration continuing nearly the same, that of inspiration increases in the inverse ratio of the diameter of the respiratory passages. This influence is very much increased if these passages are greatly contracted. The thoracic movements follow the same law.

Asphyxia may be produced: 1°. by an obstacle to the movements of the walls of the chest, the respiratory passages remaining free; 2°. by an obstacle to the passage of air into the pulmonary cells, the thoracic movements being unobstructed and becoming convulsive: now, the results are reversed in these cases; in the one the inspiratory murmur is diminished, the normal ratio between the murmur, the thoracic movement, and the manometric influence of inspiration being maintained—in the other, the inspiratory murmur is increased, this ratio being destroyed. There is then no general principle that expresses the state of the respiratory murmurs, of the movements, and their characters in asphyxia in general; to find the law that governs these relations, it is necessary to decompose this morbid state into the different forms in which it may present itself.

10th. If we try to ascertain by the manometer the greatest efforts which the inspiratory and expiratory forces are capable of in a state of health, and if we exaggerate the two movements separately, we find that the expiratory forces are more powerful than those of inspiration; if we exaggerate the two movements at the same time, we find that both are nearly equal; their simultaneous increase is at least three times their ordinary value. It is easy to see what a quantity of respiratory force is in reserve for cases where it is required. It is easy to see that some patients may habitually make a very considerable expenditure of this force without being sensible of it*.

11th. There is a direct ratio between the force and extent of the thoracic movements in inspiration and expiration, and the degree to which the manometric column rises or falls. The degree of velocity with which these movements are produced also exercises a great influence on the manometric results: this influence is very feeble if these movements are slow; it is considerable if they are rapid. The force and velocity of the manometric movements are two distinct things, each influenced by the force and velocity of the thoracic movements.

12th. The intensity of the respiratory murmurs is directly proportional to the force of the thoracic movements; their duration, to their slowness combined with their force. It is well to know this fact; it indicates the best conditions of respiration, for obtaining the greatest possible intensity of the normal or morbid murmurs.

13th. Lastly, we may establish as a general principle†, that there is a direct ratio between the murmurs, the thoracic movements, and the manometric results. Whether we artificially produce morbid conditions in the murmurs and movements, or analyse those conditions in patients that present them, the results observed correspond with the preceding principle.

14th. It results from the experiments of M. Cagniard Latour, and from my own, that grave-toned sounds produce the most extensive vibrations.

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* Such is the case with some persons who have had for a long time an effusion in the pleura, and who tell us they breathe naturally, though we find their respirations 30 and 40.

† Except, indeed, in the circumstances already mentioned.

ARTICLE VII.

MORBID CHARACTERS OF THE VOICE AND OF THE COUGH.

The morbid characters of the voice and cough have been investigated with great care by Laennec and the writers that followed him; perhaps, however, the following propositions will be found to contain some new facts or some corrections of practical importance. As I must return to this subject in treating of the diagnosis of the first stage of phthisis, (see part 2nd, chap. v. art. 2; chap. vii. art. 1) I will only notice here a very small number of the facts connected with it.

At page 25, no. 14, I pointed out the best mode of applying the ear to the chest in the auscultation of the voice. It is very important to attend to the directions given there.

1st. In some persons, those especially in whom the voice is grave and strong, and the chest somewhat emaciated, the natural resonance of the voice is so marked, that we might mistake it for bronchophony, sometimes even for pectoriloquy; but, in such cases, the resonance is the same in all parts of the chest; this circumstance is sufficient to prevent any mistake, for there is no morbid state in which the voice presents this general and uniform resonance.

2nd. This marked resonance of the voice, which, as I have said, is peculiar to some individuals, is found in almost all children; bronchophony and pectoriloquy in them deserve less confidence than at any other age; not so much perhaps on account of this source of error, against which we might guard in the way I have pointed out, as on account of the extreme difficulty of making them produce an uniform vocal sound, and of instituting an accurate comparison between the results obtained in different parts of the chest. The absence of pectoriloquy and bronchophony has in their case the same negative value; but when they are present we must distrust them, unless their characters are very distinctly marked.

3rd. From what I said (page 37) respecting the characters of the normal resonance of the voice, it is plain that in general, to enable us to place much reliance on bronchophony at the top of the lung, especially in front, it must be very distinct, though not of a high degree; but that whenever a marked difference in this respect is found between the summits of the two lungs, it may be regarded as depending on a morbid state.

4th. Moreover, the bronchophony which depends on tubercular or other indurations of the tops of the lungs, and which is heard below the clavicles, is usually too intense to be confounded with the normal resonance of the voice; not unfrequently, there will be more danger of confounding it with pectoriloquy; more especially as this, as we will show hereafter (chapter 3), may be considered as only a higher degree of bronchophony. It is well to be aware of this fact, that we may not hastily infer the existence of pectoriloquy, and mistake the first stage of phthisis for the last. The absence of the local and general morbid characters that coincide with the one, the presence of those that coincide with the other, and the practice of placing but a very limited confidence in pectoriloquy, in these circumstances, unless it be quite distinct, are the best means of avoiding this mistake. The authors of the Compendium de Medecine Pratique*, have fully comprehended this cause of error.

5th. There is not always an exact correspondence between the degree of bronchophony and the degree of tubercular infiltration of the top of the lung. This occurs in cases where a tolerably thick layer of healthy tissue intervenes between the ear and the indurated part. It is easy to see that in such circumstances, the vocal resonance must be less than when the tubercular induration is nearly complete in the entire mass of the top of the lung. As this is met with frequently, especially in the early periods of phthisis, we must not be too ready to judge of the degree of tubercular infiltration from the degree of bronchophony. There are certain combinations of signs, which I will point out in speaking of the first stage of phthisis, that may enable us to recognise the real state of the case.

6th. M. Hirtz says in his thesis†, "that a kind of pectoriloquy naturally exists at the junction of the clavicle with the sternum and in the interscapular space, and that consequently we can draw no conclusion from its existence in these regions." This opinion cannot, I think, be admitted in a manner so unrestricted. In the first place, it is not true that in the normal state pectoriloquy is heard at the sterno-clavicular articulation; I have convinced myself of the contrary in many perfectly healthy persons; with respect to the interscapular region, we find in it, in most persons, in a state of health, not pectoriloquy but bronchophony; besides, this bronchophony exists in a circumscribed space round the root of the lungs, and not over the whole interscapular region. Unless we take it for doubtful pectoriloquy, we can scarcely mistake the nature of the vocal resonance in this place. Moreover, we seldom find cavities here, another reason that renders the mistake less likely. Thus the proposition of M. Hirtz will only apply to the sterno-clavicular region; but, instead of being general, it should be restricted to those cases in which pectoriloquy and the different signs that accompany it in phthisis, are not sufficiently distinct to exclude doubt.

7th. M. Hirtz has brought forward many strong arguments against the value, either positive or comparative, of pectoriloquy as a sign of disease.

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* Compendium de Médecine Pratique, par MM. Monneret et Delaberge, vol. 1, p. 479.

† These inaugurale, Stratsbourg, p. 37.

My observations and the comparisons I have made between the symptoms and the pathological changes, are quite in accordance with his conclusions. Most physicians accustomed to clinical researches are now of opinion that pectoriloquy, considered as a sign of cavities, is of far less value than was supposed in the time of Laennec. The division of it made by him into perfect, imperfect, and doubtful, tends in itself to make us doubt its value. (15)

8th. It is the same with respect to egophony; it is much less frequent, much less distinct than bronchophony, much less characteristic of pleuritic effusion, than Laennec supposed. It is probable that, in his anxiety to find special signs of each disease, he concealed from himself part of the doubt his senses suggested; for he himself admits as possible a combination of bronchophony and egophony; he adds that this combination presents several varieties, and that it produces a certain degree of obscurity in the appreciation of the phenomenon. Egophony is completely simulated by the normal resonance of the voice in some persons; but then the voice in them is naturally bleating or egophonic. This prevents our falling into the error we might, if we were satisfied with appreciating the character of the voice in such persons by mediate or immediate auscultation alone. Old persons, and especially old women, have frequently this bleating voice; we may be certain beforehand that we will hear egophony distinct enough, in examining the chests of such persons. Even when no such circumstance exists, there is sometimes an egophonic character in the vocal resonance, in cases where on examination after death we find only hepatization of the lung without effusion. Lastly, egophony is wanting in a great many cases of pleuritic effusion, in the very conditions assigned by Laennec for its production. I pointed out at page 25, no. 14, one of the circumstances which may have led to mistakes as to the value of this sign. What Laennec has said on this subject would lead us to think that the very rule he laid down for the auscultation of egophony, contributed very much to make him hear this character of voice in cases where his previous notions induced him to look for it. One whose senses were highly cultivated, and whose mind was extremely accurate, expresses himself thus on the subject of egophony*: "in conclusion, I think, 1°.—that egophony has not, in the modification of voice it produces, any character that essentially and in all cases distinguishes it from bronchophony; 2°.—that it is only by the aid of other symptoms that we can distinguish these two phenomena. I have many times fallen into this error of taking bronchophony for egophony: on opening the body there was no effusion." The authors of the Compendium de Medecine Pratique adopt the opinion of Dance, and say†: "We gladly range ourselves on the side of those observers who consider egophony a fallacious sign. We have remarked that the bleating voice seldom presents itself in a pure form, and that it is often simulated by the peculiar *quality* of the sound of the voice in some patients." M. Piorry* regards egophony "as a sign hard to meet, and still harder to recognize." Thus the result of my observations is sustained by that of other physicians of great experience in clinical practice. There are others, contemporaries of Laennec, and whose names alone are an authority, who have come to entertain great doubts as to the value attributed to egophony by the discoverer of auscultation. M. Andral is one of those. However, egophony exists, there cannot be a doubt of it; and, in certain cases, this character coincides with pleuritic effusion, and serves to characterize it. But we may establish as a general principle: that it cannot give a character of certainty to the diagnosis, unless it is confined to one side of the chest; is audible posteriorly; does not coincide with a naturally bleating voice; is not subject, in its existence or its degrees, to the same variations that the patient can produce in his voice; and suffers the same changes in its situation as occur in the fluid according to the different positions the patient assumes. This last character is the best we can avail ourselves of in order to distinguish bronchophony from egophony; in fact the seat of bronchophony remains still the same in whatever position the patient is placed. Lastly, egophony has no true value as a sign of pleuritic effusion, unless it coincides with other phenomena, local or general, which in themselves warrant the opinion of the existence of effusion in the pleura. Sometimes we see pleuritic effusion originate and develope itself under our eyes; we follow its progress from below upwards with the aid of auscultation and percussion. In this particular case, egophony though it should not combine all the conditions I have above enumerated, may still form an element in the diagnosis; but then it will rather aid than determine the judgment. Some writers† think that one of the chief conditions of the admission of egophony, as a sign of pleuritic effusion, should be its existing exclusively in the space comprised between the vertebral column and the inner edge of the scapula, round the inferior angle of this bone, and in a zone from one to three fingers in breadth, extending in the direction of the ribs from the middle of the scapula to the nipple. I do not think we ought to restrict in this way the seat of egophony. Observations made with care, and accompanied by autopsies, demonstrate to me that it may exist in almost the whole extent of the posterior and lateral part of the chest, with the exception of the superior regions.

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* Dance, Dict. de Med. en 25 vol. 2nd ed. t. 4, p. 415.

† Compendium de Medecine Pratique, vol. 1, p. 475.

9th. Laennec has truly said that egophony is only produced when the effusion is moderate. All the cases of pleurisy with effusion I have seen confirm this conclusion. Egophony appears when the layer of effused fluid is of moderate thickness; it disappears when the mass of fluid is much increased, to reappear anew when the effusion has diminished.

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* Percussion Mediate, 1828, p. 84. Traite de Diagnost. t. 1, p. 581.

† Among others the authors of the Compendium de Medecine Pratique, t. 1, p. 475.

I have often had an opportunity of following thus step by step the march of this phenomenon, which was so happily traced by Laennec. I do not recollect ever having heard egophony when the effusion was considerable. In some patients, I have never heard it at any period, though they were in a favourable state for the production of this sign. A man, who lay in the ward St. Louis, had an enormous effusion in the right side of the chest: the dilatation of the side was very considerable; the only difference between it and the sound side in the reverberation of the voice, was that, in the affected side, the voice came direct to the ear, and seemed to issue from the depths of the lung, and pass in a close column till it reverberated at a single point; while, in the healthy side, it seemed to come from all the adjacent parts of the lung, and to reverberate indistinctly over the entire surface covered by the ear; in short, it was something analogous to bronchophony. Several observers, relying on the fact, that in some cases we hear egophony in a point, and cannot hear it either above or below this point, have concluded that the effusion had always a level, and that this was pointed out by the site of the egophony. Is it not more probable that, where egophony is produced, the layer of fluid exists in a state favourable to its production, while above and below this, it is too thin or too thick? We have already seen that egophony is not produced except where the effused fluid has a certain degree of thickness. Auscultation, which, in these cases, exhibits the respiratory murmurs diminishing gradually from below upwards, and not by any means abruptly, and percussion, which gives exactly the same result for the sound of the chest, authorise the explanation I offer. (16)

10th. Laennec says* that the most complete extinction of the voice does not prevent the production of pectoriloquy. But he does not say by what characters we can recognise this sort of pectoriloquy. I have had several opportunities of verifying the truth of the observation of Laennec and of investigating these characters. Pectoriloquy presents in such cases something quite peculiar: it is as if one spoke mysteriously, in a whisper, into the very ear. The words are perfectly distinct; it is the mysterious character of the voice that is especially striking. I do not think this phenomenon can be confounded with any other known morbid sonorous phenomenon, it presents something so peculiar; it is a sort of ventriloquy in a whisper, or rather the voice of these patients resembles that produced by speaking in a low tone while inspiring.

11th. Little use is, in general, made of the morbid characters which the cough furnishes by mediate or immediate auscultation. Laennec * has described these characters with great accuracy, insomuch that I have nothing to say on the subject. There are only two things to which I would for a moment direct attention: 1°: the normal reverberation of the cough; 2°. the cough called tubary by Laennec, and bronchial by M. Andral.

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* Auscultation Mediate; edit. de M. Andral, t. 2, p. 205. Forbes's Trans. p. 344.

† Auscultation Mediate, edit. M. Andral, t. 1, p. 114. Forbes's Trans. p. 49.

Laennec says*: "the cough in itself, and when the lungs are quite healthy, produces no particular sound in the chest; we perceive only the shock communicated to the thoracic walls, and an expiration more rapid, but perhaps less loud than the natural expiration." We would be liable to err in auscultating the morbid characters of the cough, were we to suppose that it produces no sound, in the normal state. In healthy persons, whom I have examined with the view of determining the character of the reverberation of the cough, I have found it a dull, low, rapid, and somewhat smothered sound, a little diffused beneath the ear.

When the sound produced by coughing is obliged to traverse a condensed portion of lung in its passage to the ear, its characters are different from the above. The sound of the cough is then more intense, more penetrating, more resonant; and instead of being diffused and irregularly scattered under the ear, it strikes it more directly and in a more limited surface; it passes into the auditory canal more easily and more directly. These characters of the *bronchial cough*, upon which writers have not perhaps sufficiently insisted, are of nearly as much value as bronchophony in the diagnosis of the first stage of phthisis, and of some other indurations of the lungs.(17) With respect to the morbid characters of the voice and cough when heard at a distance, it would be going out of my way to treat of them in detail; I shall only notice them in speaking of the diagnosis of the first stage of phthisis, (see 2nd part, chap. 5, art 2).

ARTICLE VIII.

OF EXAGGERATED RESPIRATION.

We know, since the researches of Laennec, that when respiration is much diminished in one lung, or in a part of one lung, it undergoes a corresponding increase in the neighbouring part, or in the opposite lung. The respiration thus augmented has been called *supplementary*, because in fact the sound part of the lung then supplies the place of the diseased portion; it has been called *puerile*, because it resembles the respiration of infants. Perhaps the name *exaggerated respiration* is more suited to it, since it is indeed, as we shall see presently, merely an exaggeration of the normal characters of the respiratory murmurs.

Laennec has described it in a general way only, and has left undetermined its exact characters, the circumstances in which it shews itself, its differential diagnosis, its march, and its value as a diagnostic and prognostic sign. The study of these is of some interest, and may throw much light on the seat, the extent, and the course of the diseases in which supplementary respiration makes its appearance.

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* Auscultation Mediate, edit. M. Andral, t. 1, p. 114. Forbes's Trans. p. 49.

I. The character of exaggerated respiration is, a pure and simple increase of the inspiratory and expiratory murmurs. This increase affects both the intensity and duration of these sounds. The increase in expiration is proportionally greater than in inspiration. The inspiratory murmur, whose normal number is 10, may rise to 12 and 15; the expiratory may attain the same elevation. We see, therefore, that the increase in expiration is proportionally much greater than in inspiration. This exaggeration of the expiration is the most remarkable character of supplementary respiration, the one to the accurate analysis of which we should pay most attention, because it may lead us to suppose the existence of a much more serious morbid state than is really present. The increase in expiration is not always so great as we have just stated; it may stop at 8, 10, 12, that of inspiration being 15.

In exaggerated respiration, the respiratory sounds suffer no alteration by perversion; they preserve their normal murmur; but this murmur assumes, without however any change in its nature, a clear *quality*, which might, and which has been sometimes confounded with a low degree of the bronchial character. We shall point out hereafter the mode of distinguishing them.

In short, the characters of supplementary respiration are three: 1°. increase in the intensity and duration of the respiratory murmurs; 2°. a greater proportional increase in expiration than in inspiration; 3°. a slight shade of the blowing or clear *quality*. The most general character of supplementary respiration, is the simple exaggeration of the normal murmurs, without any change in their nature.

II. There are several circumstances in which exaggerated respiration may be confounded with certain morbid forms of respiration whose diagnostic import is quite different. These circumstances are the following:

1st, The increase of expiration that takes place in the first stage of phthisis, may be mistaken for mere exaggerated respiration; the following characters will distinguish them:

In supplementary respiration, the increase in inspiration affects both the duration and intensity of the sound—in phthisis, the intensity alone is augmented, and in general the duration is diminished.

In the first, the number that marks expiration never exceeds that of inspiration—this often happens in the second.

In the inspiration and expiration of phthisis, the character of augmentation is combined with a certain roughness, hardness, and dryness, which are quite foreign to exaggerated respiration.

In the first stage of phthisis, the bronchial character is sometimes preceded by a slight shade of metallic *quality*; but this does not shew *itself in* inspiration till after it has co-existed with expiration, whereas the slight clear *quality* of supplementary respiration appears at once in both murmurs. When the alterations of *quality*, which belong to the first stage of phthisis, exist in both inspiration and expiration, they have become too well marked to be confounded with the slight shade of clear *quality* of exaggerated respiration.

Besides, in phthisis, the alterations of *quality* continually tend to increase in intensity; in supplementary respiration, the clear quality we have noticed remains always the same. An obscure or dull sound on percussion usually accompanies the respiration of a tuberculized lung; in supplementary respiration the sound is rather increased than diminished.

In the first, the usual seat of the morbid characters is the top of the lung; they are localized below the clavicle—this localization is very rare in the other.

2nd. In emphysema of the lungs there is also increase of expiration, as in exaggerated respiration; but these two morbid states differ essentially in other respects:—in emphysema, the inspiration is diminished at the same time that the expiration is increased. With these characters is joined that of roughness and dryness. The sound on percussion is almost tympanitic. These characters usually exist over the whole extent of the chest.

Nothing of this kind is met in supplementary respiration; moreover, the accompanying signs render the diagnosis easy.

3rd. Between exaggerated respiration, and rather strong natural respiration in the adult, there is this difference: that, in the latter, expiration has at the most increased only 1, 2 or 3 degrees, that respiration is the same in all parts of the chest, and that there is not the co-existence of any morbid phenomenon—whilst, in the former, these circumstances are reversed. The same differential signs apply to exaggerated respiration compared with the respiration of the child; but other circumstances may also serve to distinguish them: both present in their *quality* a shade which reminds one of the first degrees of metallic *quality*; but we feel distinctly that, in the respiration of the child, the penetration of the air into the pulmonary tissue is more easy, more uninterrupted, more complete, and more profound than in exaggerated respiration.

4th. The differential diagnosis between exaggerated respiration and the normal respiration of the adult or child may in fact become necessary. Exaggerated respiration has been sometimes regarded as the purest and most complete natural respiration; the expiratory murmur that accompanies and makes part of it has been taken for a distinct, independent morbid sound; this, however, was at a time, when the existence of two distinct respiratory murmurs was not fully admitted. Such is the following passage, in which the characters derived from auscultation in lobular pneumonia are analyzed: "With the exception of these cases in which the inflamed lobules are situated towards the exterior of the lung, we hear at every point of the thoracic walls, vesicular respiration as pure, complete, and profound, as in the normal state. In some cases of this kind, however, I have been struck by the appearance of a phenomenon which usually shews itself when a certain quantity of tubercles are developed in the parenchyma of the lung; I mean the expiratory murmur: I have heard it distinctly in persons in whom the different rational signs of pneumonia were strikingly manifested, at the same time that neither the sound of the chest on percussion, nor the vesicular murmur was in any degree altered. As the disease advanced towards resolution, the expiratory murmur gradually disappeared, and the cure once complete, no further trace remained of it*." This, which is here noted as occurring in some cases, is a general fact, but more or less marked according to the nature of the case.

III. Three circumstances may produce exaggerated respiration: 1°. nervous influence, more or less transitory, which I merely notice; 2°. external physical influences, which it is equally useless to dwell upon; 3°. internal physical influences, which are, in general, organic alterations. The exaggerated respiration that depends on nervous influence is characterized by being general and transitory, by returning to its normal limits as rapidly as it passed them. It is the same in general with respect to exaggerated respiration depending on external physical influences. On the contrary, the essential character of supplementary respiration depending on internal physical causes, especially organic causes, is, that it is localized in some one part of the respiratory apparatus, and that it appears, and, still more, disappears slowly, like the alteration that produces it.

The general principle that governs this third class of causes, is that: whenever respiration is impeded in a portion of the lungs, the sound parts supply the want of respiration in the diseased. Now, the degree and extent of supplementary respiration is always proportional to the degree and extent of obstruction. The lung that, in the normal state, respires as 1 in each of its parts, will respire as 2 in its superior half, if the inferior has entirely ceased to act. In the article *Auscultation* of the Dict. de Med. Pratique (tom. 3, p. 655) M. Andral has properly dwelt on the obstacles to circulation and respiration, considered as causes of exaggerated respiration.

It is in pneumonia especially that exaggerated respiration presents its most elevated forms. It is, in general, more intense in proportion as the parts in which it exists are nearer the affected parts: hence, it is more intense when it presents itself in one half of the lung, the other half being affected, than when it exists in the whole of one lung, the other being diseased in its entire mass; when the pneumonia occupies the posterior of one side of the chest, it is more intense in the anterior part of this side, than in the opposite sound side.

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* Auscultation mediate; edit. de 1837, vol. 1, p. 648.

Supplementary respiration may manifest itself in any part of the chest; but we meet it more frequently in the front than behind, and above than below. It is, as I have said, always most intense in the parts most near the seat of the disease. Hence, its diagnostic value in certain cases where the existence and seat of the affection are doubtful, as, for example, in cases of central pneumonia.

Its character is to decrease in proportion as we recede from its place of maximum intensity, and to become confounded either with the natural or the morbid respiration, according to the direction in which we move.

The signs with which it co-exists are those of the diseases that produce it. These signs are sometimes very obscure. Combined with supplementary respiration, they sometimes simulate remarkably other affections. It would be tedious to descend into the details of these differential diagnoses; the distinction will be in general easy, when the mind has clearly before it the general principles that govern the different modifications of the normal murmurs.

IV. In general, exaggerated respiration begins along with the disease itself; it then shows itself in its immediate neighbourhood; it follows all its phases: increases, decreases, and disappears with it, in this case, its duration is the same as that of the disease that produces it. But, in certain circumstances, it does not make its appearance till the period of resolution; then, it exists not only in the vicinity of the affected part, but in the part itself: respiration, which had been at first much diminished there, rises by degrees, and reaches its normal standard; but instead of stopping here, it sometimes passes several degrees beyond it, and then constitutes supplementary respiration. This occurs in pneumonia, whenever resolution takes place by successive steps. Suppose, for example, a pneumonia occupying all the posterior part of a lung: resolution, instead of proceeding uniformly in all the affected parts, takes place from above downwards, in such a way, that the superior part of the lung has resumed its functions, while the inferior part is still hepatized: in such a case then we find supplementary respiration appear successively from above downwards, and disappear above, in proportion as with the process of resolution it is propagated downwards. In this particular case, the production of exaggerated respiration rests on the same principle as in ordinary cases; that is, that the portion of lung which first returns to its normal state supplies the place of that which is ineffective, and ceases from its exaggerated action, when the latter has resumed its normal condition.

Supplementary respiration has three periods in its duration: it is feeble at first; increases afterwards in proportion to the impediment to respiration; decreases as this diminishes, and disappears with it. However, its disappearance does not always correspond with the time of the complete resolution of the disease: it continues for some time after every trace of the affection has disappeared, sometimes several days, sometimes more. Its continuance in this way, when the resolution of the disease is complete, appears to depend on a kind of habit of respiring more strongly than usual, which the patient has acquired, and which only ceases by degrees. In fact the production and the different degrees of exaggerated respiration are influenced by two causes: 1°. the facility with which the air penetrates the air cells; 2°. the force employed by the patient to effect this penetration. The first ceasing by the resolution of the malady, the second is sufficient to keep up, for a time, the exaggerated respiration.

In this kind of respiration, inspiration returns to its normal state sooner than expiration. This is one of the applications of the general principle I formerly laid down, namely, that in all kinds of morbid respiration when the expiratory murmur is increased, it returns to its normal state more slowly than the inspiratory.

We may say, in general, that the progress, the degrees and the modifications of supplementary respiration, are regulated by the progress, the degrees and the forms of the diseases that determine its existence. Hence its diagnostic value in these affections.

V. In fact, exaggerated respiration is to the disease on which it depends, what the shadow is to the substance. It may lead us to suspect the existence of an obscure affection, hidden deeply in the interior of the lungs, or enable us to discover its site when other signs have proved its existence. We have had this year at the hospital la Charité, in St. Louis's ward, three patients affected with central pneumonia: the rusty, straw coloured, viscous sputa, and the entire general phenomena left no doubt of the existence of pneumonia, and yet none of the usual local signs of this disease could be discovered either by auscultation or percussion; there was no pleuritic pain, we knew not on which side the pneumonia was, but the existence of well marked supplementary respiration in one of the sides soon removed all doubt: and in fact in two of the cases the pneumonia extended from the centre to the circumference; bronchial character and crepitating ronchus made their appearance, and the diagnosis founded on the supplementary respiration, was thus confirmed. In the other case, the exaggerated respiration disappeared along with the morbid character of the sputa and the general phenomena.

When supplementary respiration exists to a considerable degree in the whole extent of one side of the chest, it should lead us to suspect some affection of a serious character, if not in its nature, at least in its degree and extent, in the other side. It is however necessary to remember that there is not always an exact correspondence between the degree of exaggerated respiration and the degree of the affection upon which it depends. *In some* persons, this intensity of supplementary respiration is perhaps as much owing to an easily excited nervous system, as to the organic alterations themselves.

Perhaps if the symptomatic and anatomical facts that correspond were accurately analysed, we would find that the character of augmentation of the expiratory murmur which respiration presents in several morbid circumstances, is, in the end, but the character of exaggerated respiration; and that the differences we observe in these cases depend entirely on the combination of different morbid characters with the exaggeration of the inspiratory and expiratory murmurs; but this study not being of a kind to add to or take from the value of the morbid characters just passed in review, and therefore not being of any practical use, I will not occupy myself with it here. (18)

ARTICLE IX.

OF THE PULMONARY CRUMPLING MURMUR OR RONCHUS.

For some years past, in carefully auscultating the chest in certain classes of the sick, I have been struck by a sound which is quite peculiar and different from all those hitherto described, and which is sufficiently permanent to have allowed me to study its character, progress, &c. The impression this sound leaves on the ear, is that of the crumpling of a tissue pressed against a hard body; and as there is every reason to think that, in this case, it is the pulmonary tissue that is thus crumpled, it is natural to call the sound so produced *pulmonary crumpling sound.*

I. *Its physical characters.*

The general character of this sound is that it gives the ear the sensation of squeezing or crumpling. This sensation is so peculiar that we always recognize it easily from this general character. It seems as if the eye, receiving the same impression as the ear, saw the pulmonary tissue struggling with effort and with noise against the obstacle that obstructs its expansion.

The pulmonary crumpling sound may present different forms and degrees: 1°. in its highest degre it is the new leather creak *(bruit de cuir neuf)*, not differing from that of pericarditis except in its *quality*, which is somewhat more acute; 2°. in a less marked form it is a kind of plaintive moaning sound, varying in tone with the state of oppression of the patient, with the force and rapidity of the respiration; 3°. lastly in a still lower degree, which is the weakest and most common form, it perfectly resembles the light, quick, dry sound produced by blowing on very fine paper.

Although it is sometimes very intense where it is audible, it is very seldom propagated beyond the point in which it is generated. For this reason, and from the limited extent of surface it commonly occupies, it is necessary, in most cases, to listen with some attention to be able to hear and analyse this sound.

In general it co-exists with inspiration alone; I have however several times heard it during both inspiration and expiration; but more marked in the former.

The intensity of this sound is in general proportional to the force with which the patient respires. This is what we should expect: the column of air that struggles to dilate the lung being stronger and more rapid, the crumpling of the pulmonary tissue being greater, the sound produced in this way must be more intense.

Some phthisical patients are sensible of a feeling of restraint, of uneasiness, sometimes even of pricking pain, in the points where the pulmonary crumpling sound is heard. But with the far greater number of patients there is no direct connexion between these two classes of phenomena; for the morbid feelings above noticed, are met with in a very large number of cases in which the crumpling sound does not exist at all; and vice versa. We find also these two classes of phenomena existing separately in distinct parts of the chest. They are therefore two effects of a common cause, the anatomical alteration of the lung, but effects independent of each other. I have as yet seen only a few cases in which there appeared to be a kind of dependence between these two phenomena. In one, for example, a well marked pulmonary crumpling sound existed at the top of the left lung, and the patient felt in the same part a sensation of *inward rubbing,* which, he said, made respiration more difficult there than on the opposite side. The alteration increased, the local phenomena assumed a more intense form, the crumpling sound disappeared, and with it the feeling of inward rubbing.

II. *Diseases in which it appears.*

Notwithstanding the care with which I have examined every patient I met affected with diseases of the chest, I have as yet heard the pulmonary crumpling sound in the three following circumstances only: 1°. in a woman who died in 1834 at the hospital Saint Antoine, both whose lungs were compressed by an enormous encephaloid tumour seated in the anterior mediastinum; 2°. in a patient, who lay at No. 17 ward of St. Martha, hospital of la Charite, in whom we found, on autopsy, at the top of the left lung, a very large non-tuberculous cavity, regular in form, containing only air, and bounded superficially by walls two or three lines thick, firm, flexible, and resembling perfectly a piece of leather of the same thickness. In this case, the pulmonary crumpling sound, which was very intense, was produced by the to and fro motion of this wall, caused by the passing of the air in and out of the cavity; in this case, too, the sound was heard both in inspiration and expiration. 3°. Lastly, this sound is heard chiefly in the first stage of phthisis.

1st. It is only at a certain epoch of phthisis that this sound is met. This epoch includes the last half of the first stage and the commencement of the second. Sometimes I have seen it appear before the *quality* of the respiration had assumed the bronchial character; but, in general, I have found both make their appearance at the same time. It has always disappeared when the dry crackling ronchus had passed to the moist state; when the bronchial character had acquired great intensity and extended from expiration to inspiration, that is, when the softening of the tubercles had commenced. I have never seen it persist during the formation of cavities, unless it was produced in their vicinity.

2nd. Not having seen the patient in the first case I mentioned, during the early periods of the developement of the tumour, I cannot say exactly what may be the precise degree of pressure a tumour must exercise on the lung to produce the crumpling sound; but one thing is certain, that, both in this case and in the second, the sound was more marked than in cases of phthisis.

3rd. In the first stage of phthisis, the pulmonary crumpling sound coexists with the other signs of this period: thus, with the dry crackling ronchus; with the bronchial character in expiration alone, or in both expiration and inspiration, but at a low degree; with an increase of the duration and intensity of expiration, expressed by the numbers 10 or 15; with a diminution of the duration of inspiration, expressed by the numbers 6 or 8; with marked dullness of sound on percussion and decrease of the vibration of the voice in the corresponding point; lastly, with distinct bronchophony.

4th. The signs that coincided with this sound in the case of the non-tuberculous cavity, were: mucous ronchus with large bubbles, gurgling ronchus, and cavernous respiration. The only sign coexisting with this sound, that was remarkable, in the case of tumour in the mediastinum, was extraordinary diminution of the inspiratory murmur.

5th. The site of the crumpling sound is wherever the anatomical conditions necessary for its production exist; in the case of mediastinal tumour it was heard in the front of the chest, and some way down both sides; in the patient who had the large excavation in the top of the lung, it was produced around the part that was dull on percussion. In phthisis, it exists at the tops of the lungs only; most usually in front below the clavicle, sometimes behind in the supra-spinal fossa. I have scarcely ever observed it at the same time in both sides. In fact we seldom find the tops of both lungs effected by phthisis to the same extent, and undergoing at the same time equal alteration; almost always one is more changed than the other; we have then, in the one where the pulmonary crumpling sound does not exist, the signs of a period, either earlier or later, than that at which this phenomenon usually appears.

6th. It was only in one case, that in which the sound existed in its most intense form, that I was able to perceive by the touch any trace of the pulmonary crumpling; and even here the vibration produced by it was very slight, often indeed very obscure. This sound differs very much in that respect from the pleuritic friction sound, which is usually accompanied by a vibration very easily felt. It is easy to conceive, indeed, that friction should be more capable of producing vibrations perceptible to the hand than mere crumpling.

III. *Relation between the sound produced and the physical state of the organ.*

I have often had an opportunity of examining the lungs in cases where the crumpling sound had been audible till death. 1°. In the case of tumour in the mediastinum, both lungs were flattened anteriorly, they presented here and there indurated nuclei, and it was obvious that the column of air introduced by inspiration must have found it difficult to dilate the surrounding pulmonary tissue. This state, it is plain, is very analogous to that of a tuberculized lung. 2°. In a consumptive, who died in the hospital, the superior half of the left lung (where the crumpling sound was heard) was enveloped by a thick false membrane, which was also adherent to the pleura opposite; the top of the lung, thus imprisoned, was reduced to nearly half its volume, and its expansion very much impeded. Furthermore, the entire circumference of this part of the lung was infiltrated with miliary tubercles which rendered this outer layer tolerably dense, while its central part was still quite pervious to air. In the top of the right lung, where the crumpling sound had never been heard, only some few very small miliary tubercles were found scattered here and there, In another patient, who died in the hospital of disease unconnected with the chest, we found the cause of a pulmonary crumpling sound, which had been heard at the right side, to be some large tubercles seated in the top of the lung. In this case there was no adhesion of the pleuræ. 3°. In the patient, that died at No. 17 ward of St. Martha, a thick, dense, indurated layer of pulmonary tissue, resembling a piece of leather, was kept continually flapping forwards and backwards by the passing of the air in inspiration and expiration in and out of the cavity it surrounded.

In conclusion, we see that the anatomical conditions of production of the pulmonary crumpling sound, are the following: 1°, a mechanical obstacle to the expansion of the lung; this obstacle having its origin, either at the exterior or the interior, or in both at the same time; 2°, lobular induration of the pulmonary tissue, so that, in the midst of spots impervious or almost impervious to air, there are still some tolerably free; 3°, the alternate flapping to and fro of a thick and dense lamina of fibrous tissue.

IV. *Its diagnostic and prognostic value.*

I have seen several cases in which aneurismal or other tumours compressed the lungs to a certain extent; but in two of them only was the crumpling sound to be heard. In these two it was quite constant, well marked, and so distinct that it was impossible to mistake it. In such cases then, the existence of this sound is an additional sign to those furnished by auscultation and percussion; but we can infer nothing from its absence.

This sound existed in about $\frac{1}{8}$ of the cases of phthisis, in which I carefully noted the auscultatory signs. The smallness of this number depends no doubt on the circumstance, that as it exists only during a limited period, it is unobserved in several cases. When this sign does exist, however, it is tolerably constant; it is not like some other sonorous phenomena, unsteady or fugitive. By making the patient respire in a suitable manner, we may always hear it, provided the period of its duration be not passed. In conclusion, its situation almost exclusively in the top of the lung, its coexistence almost constantly with the other signs that suggest the idea of phthisis, its progress regulated by laws that do not vary, give it considerable weight as a sign of phthisis in the cases where it exists, at the same time that we can draw no conclusion from its absence. As it never appears except in the earliest stage of the disease, the prognosis derived from it is only serious, on account of the usual progress of the malady of which it is a sign. It is almost always in cases of acute phthisis I have met it; in fact the miliary form of tubercular infiltration, a form by much the most frequent in acute phthisis, seems more favourable than any other to the developement of this sound.

V. *Progress of the pulmonary crumpling sound.*

We have already seen at what period of phthisis it appears, and when it ceases to exist. When we can thus follow it during its entire duration, we find it at first very slight, very feeble, though always giving to the ear a peculiar and very distinct sensation. After some time it augments a little, because, independently of the gradual increase of the physical alteration of the lung, the oppression of the chest, and the consequent increased respiratory efforts made by the patient, render it more intense. When it is about to disappear it becomes more moist, less rough, less hard; we hear it less distinctly, and at length we hear it no more. Its duration varies, according as the disease is acute or chronic in its progress; in the latter case it persists a very long time; in the first, it sometimes appears only for a few days, and disappears suddenly. It continued constantly in the patient, whose lungs were compressed by the encephaloid tumour, and also in the patient that had the excavation in the top of the left lung.

VI. *Its differential diagnosis.*

1st. The phenomenon with which it may be most easily confounded, is the dry crackling ronchus, (see farther on, *crackling ronchus,* Art. X.) Both are usually met with in the top of the lung; both appear in inspiration chiefly; both have a rough, hard, dry, and well marked character; both belong to the same period of phthisis; and yet they are two very distinct phenomena: the crackling ronchus is infinitely more frequent than the crumpling sound, and the impression it makes on the ear is altogether different. In the one case, it is a single rapid sound, which arises and ceases instantaneously, like the sound caused by the sudden rent of a piece of silk; its tone is essentially grave: in the other case, the tissue seems, instead of crackling and being torn, to be crumpled, or to unfold itself; the sound is more prolonged, more continuous; its tone is rather more acute.

2nd. The pulmonary crumpling sound is so different from the sibilant and sonorous ronchi, which are also sometimes heard at the top of the lung, that with a little experience in auscultation, it cannot be confounded with these; and still less with the different moist bubbling ronchi, which may be met with in the same situation; the bubbling and the moist character are both so unlike the crumpling sound, that the ear is never tempted to compare them.

3rd. The pleuritic friction sound might more easily be mistaken for the pulmonary crumpling. We may distinguish them by the following characters:—the latter is continuous; in listening to it, the ear feels no sensation of displacement; it is produced, almost exclusively, in the top of the lung; it coexists with the signs of the earliest stage of phthisis; the patient has usually no sensation from it; the hand cannot appreciate it, and it exists almost exclusively in inspiration. The pleuritic friction sound, on the contrary, is composed of little jerks or shocks; the ear receives the sensation of displacement from above downwards, and from below upwards, according as it is heard during inspiration or expiration; it almost always coexists with both periods of respiration; it is usually produced in a part (the middle of the posterior part of the chest,) where the other is never met; and it is in general appreciable by the hand as well as sensible to the patient. Lastly, the two sensations felt by the observer, that of pulmonary crumpling on the one hand, and that of pleuritic friction on the other, are altogether different. (19)

ARTICLE X.

THE DRY AND HUMID CRACKLING RONCHI AND THEIR TRANSFORMATIONS.

I. *Sound produced.*

1st. The *crackling ronchus* or *sound of pulmonary crackling* (râle de craquement ou bruit de craquement pulmonaire) differs, in the nature of its sound, in the sensation it produces on the ear, from all the other morbid sounds of the chest, which are called *ronchi*, and still more from those that have not that name. It consists in a sensation of *crackling*, which is quite peculiar, and of which we cannot give a better idea than by comparing it to the different sounds which are called *crackling*. This sensation cannot be described, it must be felt; but, in general, when once heard, it is always easily recognized, at least in its higher degrees.

2nd. This ronchus presents itself in two very distinct forms, each of which marks a period of its duration. When it first appears, and for some time after, it produces on the ear a sensation of dryness, and it deserves then the name of the *dry crackling* ronchus; after a time more or less long, it passes insensibly to the moist. The ear appreciates distinctly this transition, and is at the same time sensible, that the nature of the sound has changed a little; it is indeed still the sensation of crackling, but a crackling that tends to become mere mucous ronchus. In fact, we will hereafter see that this transformation of the humid crackling into the mucous ronchus, is one of the changes through which it must pass, before it becomes the gurgling ronchus.

3rd. This ronchus is not, as might be supposed, a single homogeneous sound; it is formed by a succession of small sounds; each of these is a crack, and it is the sum of these sounds during one of the respiratory movements, that constitutes the crackling ronchus. These little successive sounds do not exceed 2 or 3 in number. These characters belong essentially to the dry crackling ronchus. With respect to the humid, it is also composed of several successive sounds, nearly the same in number; but these sounds assume from day to day still more the form of bubbles; in the end they present perfectly the bubbling character, and then the description of them belongs to the bubbling ronchi. The crackling ronchus is found coexisting with inspiration more exclusively in proportion as it is more dry. As it becomes humid, it is heard in expiration also.

4th. Unlike the pleuritic friction sound, which is also composed of successive jerks or sounds during one of the periods of respiration, the crackling ronchus always leaves on the ear the impression of having come from a distant point, a point remote from the surface. If it happen that the physical cause of it is situated at the periphery of the lung, which is not often the case, there is still in the character, more or less superficial which it then presents, something that enables us to distinguish it readily from the pleuritic friction; the ear appreciates accurately, even in these exceptionable cases, that the sound originates in a point beyond the limits of the pleura. We know that the sense of hearing, when accustomed to the different shades and degrees of sounds, appreciates perhaps even better than that of sight, the distance through which the sonorous wave has passed.

5th. With respect to its seat, the crackling ronchus has also something quite peculiar. It is never heard, in the diagnostic conditions we are now supposing (first stage of phthisis), except in the top of the lung. If we sometimes hear it in points more or less distant from this, it is when the signs of softening or of a cavity have already appeared in the top of the lung; it is when the tuberculization, invading successively and from above downwards the whole mass of the lungs, appears in its first stage in the middle or at the base, while cavities are already formed at the top or the middle. But these exceptions do not alter the preceding rule as to the seat of the crackling ronchus, because I only apply this rule to the diagnosis of the first stage of phthisis.

6th. It is usually in the very top of the lung that the dry crackling sound is heard: as in the supra-spinal fossa, and above and below the clavicle. With respect to its maximum intensity and frequency in front, behind, on the right, or left side, it follows the same course as the disease on which it depends. The dry ronchus is in general confined to a much smaller space than the humid. We meet it here and there in scattered points of small extent.

Thus, then, the crackling ronchus goes through the same course of developement as the physical cause that produces it (tuberculization of the lungs); it makes its first appearance, in general, at the top of the lung, and if it be distinctly recognised in the mammary region, or in any other part remote from the top, it denotes the existence of a much greater degree of change above. Hence, in the tabular view of my cases, we invariably find, that if the dry crackling ronchus existed towards the middle of the lung, the mucous and gurgling ronchus, or at least the humid crackling, was found above. Hence, when we follow, in the same patient, all the successive stages of phthisis, we see the dry crackling ronchus invade the lungs successively from above downwards, and leave in the part it abandons, as marks of its progress, sounds which are but successive degradations of this ronchus, and which indicate an increase of the disease.

7th. Of 55 patients in whom I have ascertained the existence, and traced the characters and the progress of the crackling ronchus, I have only met 9 in whom it was not constant. If we examine the circumstances that in these 9 cases coincided with this inconstancy of the ronchus, we find that in them it was dry, that it was in its earliest stage, and that it became more and more constant, in proportion as it had existed longer, in proportion as it had passed to the humid character. It is easy to see that this must be so: when the physical conditions on which it depends have only reached the point necessary for its production, it is obvious that it cannot be produced in a very regular and constant manner; it is plain also that this regularity, this constancy, ought to be met with afterwards in proportion to the degree of developement of the preceding physical conditions.

Thus, we may, in general, lay it down, that the crackling ronchus is constant in its nature, but that its regularity and its constancy increase with the duration of its existence.

8th. But one circumstance which is nearly invariable is, that the crackling ronchus belongs more exclusively to inspiration in proportion as it is nearer its origin and its period of dryness; and that it tends more and more to invade expiration also, as it recedes farther from its origin, and is passing to the humid state, always, however, continuing most marked in inspiration. I have often observed this *successive* occupation of the two periods of respiration by the crackling ronchus; and amongst the phenomena of respiration which I have hitherto studied and described, there are few that follow a more regular course than this.

We will see hereafter, when we come to speak of the successive transformations which the crackling ronchus undergoes, that these transformations have also their law of coincidence with one or other period of respiration, a law expressed by the following formula: the successive transformations of the crackling ronchus coexist more equally with both inspiration and expiration, in proportion as these transformations indicate a more advanced degree of the crackling ronchus; as, for example, the gurgling ronchus.

II. *Morbid circumstances in which the crackling ronchus is produced.*

1st. Phthisis pulmonalis is the only disease in which this ronchus is heard. Though I have sought for it with great care in other affections of the chest, I have never met it except in tuberculization of the lungs; this applies, however, only to the earlier forms of the ronchus; it is especially applicable to the period when it is still dry; for in proportion as it assumes the humid form, as it acquires a greater analogy with the mucous ronchus, it may, if we consider it independently of its progress and its seat, if we view it in an isolated manner, be confounded with some of the ronchi that are produced in other diseases. But if, instead of looking at it abstractedly, and isolated from the circumstances by which it is surrounded, we form our opinion of it from its physical characters, its progress and its site, we may consider it peculiar to phthisis, particularly if we take into account the very peculiar nature of this sound.

2nd. It appears, from the cases I have collected, that the crackling ronchi do not belong to one form of phthisis in particular more than another. It is by no means the same with respect to the period at which they appear; they present, in this respect, a character of constancy which is one of the best foundations of their diagnostic value. The dry crackling ronchus belongs to that period of the first stage of phthisis, which I have called the 2nd phasis, whilst the humid crackling ronchus belongs to the 3rd phasis, and establishes in some degree the transition from the first stage of the disease to the second. It appears from this that the dry crackling ronchus is not the first symptom that appears in phthisis: several of the modifications in duration of the respiratory murmurs precede it; the time at which it shews itself is nearly the same as that at which we observe the pulmonary crumpling sound, when it exists.

3rd. The dry and humid crackling ronchi coexist, for the most part, with a certain number of phenomena, which, like them, form part of the symptoms of a determinate phasis of the first stage of phthisis: 1°. with the dry crackling ronchus we usually find, in the same points, an augmentation of the intensity of inspiration, which, in general, does not go beyond the number 12; a diminution of its duration which seldom descends lower than 8 or 9; an increase of the extent and intensity of expiration, which varies between the numbers 6 and 10; sometimes, however, it rises higher, the ronchus continuing dry. It is not often that the bronchial character, even in its lowest degree, exists at the same time as the dry crackling ronchus; unless, indeed, the alteration of *quality* has as yet appeared only in expiration. A moderate degree of bronchophony is often observable at this period of phthisis. The sound on percussion is already a little obscure. The vocal vibration is somewhat less opposite the points where the ronchus is heard, and the patient complains sometimes of a peculiar feeling of oppression, of obstruction in the interior of the chest. I have seen some, but very few indeed, who said they felt in the chest a kind of *crackling* (this was their expression), and they sometimes pointed to the spot where this ronchus was heard; 2°. but in proportion as the ronchus passes from the dry to the humid state, we find the numbers that represent the augmentation of the intensity of inspiration, and of the intensity and duration of expiration, gradually increase; we find these numbers rise to 12, 15, 18, and even 20, when the crackling ronchus has become quite humid. At the same time, the bronchial character has appeared, or has increased in intensity, and has extended to inspiration.

Strong bronchophony, sometimes even imperfect pectoriloquy, are united with the preceding signs; the sound on percussion has become more obscure or even dull; the vibration of the voice is much diminished, and the local sensations felt by the patient are more marked than during the preceding period.

III. *Course.*

Thus the crackling ronchus begins to shew itself, after the respiratory murmurs have already suffered a slight modification in their duration and intensity. At this time it gives distinctly the impression of something dry, hard, and rough, crackling several times in succession, and returning at each new inspiration; then it becomes a little humid; the modifications in the duration and intensity of the respiratory sounds are augmented; alterations in the *quality* of these sounds, as well as different other signs, make their appearance; the number of the successive cracklings that compose this ronchus increases a little, and these cracklings, at the same time that they become more marked and more humid, begin to appear in expiration also, and are soon established there, and coexist with it almost as perfectly as with inspiration. Such is the usual course of this ronchus.

IV. *Transformations.*

During this general course, the crackling ronchus undergoes certai transformations, which flow in succession one from the other. These transformations, instead of being studied in an abstract and isolated manner, as has been in general hitherto done, deserve to be reunited under one type, and to be viewed as links of one chain, on which they mark the successive phases through which the disease must pass, in its progress from its slightest to its most serious anatomical conditions.

If, from the moment the first symptoms of phthisis appear, we follow attentively all the successive changes the disease suffers, up to the period of cavities and death, we see that amongst the ronchi the dry crackling commences the scene; that by an insensible fusion, it is transformed into the humid; that this assumes gradually the bubbling character; that soon after, without the ear being able to mark the limits between them, this becomes the mucous ronchus: this is, however, the mucous ronchus with large, moist bubbles; it is localized in the upper part of the chest, and is characterized by a peculiar, somewhat metallic *quality*, by a particular impression on the ear, that prepares it for the cavernous character. In fact, this *quality*, this particular impression, becomes gradually more and more developed; a ronchus which deserves the name of cavernulous (a name given to it by M. Hirtz, a physician of Stratsburgh) succeeds the mucous ronchus, and is itself in succession changed into the proper cavernous or gurgling ronchus *(râle de gargouillement)*. This successive transformation of the primary form into its secondary forms is scarcely ever wanting, when we have an opportunity of observing the disease from the first appearance of the symptoms, and when the first form, the dry crackling, has been observed. Besides, whether the dry crackling has or has not *existed, the succession* of secondary forms is always the same.

In that case it is the humid crackling ronchus that begins the series. But the great number of observations I have made on the first stage of phthisis, induces me to think that the dry crackling ronchus is still more frequent than the tabular view of my cases would lead one to suppose. The want of opportunities of observing cases of phthisis in the first phases of the first stage, and the rapidity with which, in some instances, we see the dry crackling change to the humid, appear to be the reasons that this ronchus has not been recognized and described by authors, and that it is set down in some only of my cases.

Indeed, we have seen patients in whom the process of tuberculization proceeded with such rapidity, that all the foregoing ronchi were developed in succession in the course of a few days; we have seen this entire series of transformations completed in less than 10 days in one patient, and in 10 days in another. But the passage from one form to another is usually more slow. Thus, in most of my cases, the transformation of the dry into the humid ronchus took place in a period of from 8 to 10 days for acute phthisis, and from 20 days to 2½ and 3 months for chronic phthisis. We sometimes, however, find in chronic phthisis, one period completed more rapidly than the others; and then the time between the two epochs, between the two forms of the ronchus, is shorter; thus in one case of chronic phthisis, nine days sufficed for the crackling ronchus, which was at first dry, to pass to the humid state.

This peculiar course, these successive transformations of the crackling ronchus, reminds us of the general fact that governs the different modifications of the *quality* of the respiratory sounds: there is between the dry and humid crackling, the mucous and gurgling ronchi, the same relation as between the metallic *quality*, the bronchial character, the cavernous character, and amphoric respiration. I have already said, in speaking of the general facts that govern the ronchi of phthisis, that the successive changes of their physical characters is accompaned with changes in their coexistence with one or other period of respiration. They are observed to belong more exclusively to inspiration, in proportion as we approach nearer the commencement of the series they compose; and more equally to both periods, as we approach the end of the series.

The modifications of the respiratory sounds which I have considered hitherto, are connected with the ronchi of phthisis by a most intimate relation. The course of the one series is simultaneous with that of the other; when the analysis of the one has been well made, it is very serviceable in the analysis of the other; with some slight exceptions, all the signs, all the groups of symptoms conduct the mind, by different routes, to the same conclusion. Hence the importance of including in one view all the elements of a problem in diagnosis. How much stronger the conviction becomes, when several kinds of facts, differing in nature, all tend by their concurrence, by their common progress, by their *convergence* towards the same result, to awaken the same thought.

V. *Differential diagnosis.*

The different forms of the ronchi of phthisis are so easily distinguishable, as to make it unnecessary to lay down their differential diagnosis: the dry crackling ronchus can never be confounded with the gurgling ronchus; it is the same of the other forms of these ronchi, when we compare those that are remote from each other in their natural order of succession; but in their points of contact, in the gradual transition from one to another, the sensation of one passes into that of the other, by such imperceptible shades, that it is impossible to establish any distinct limit between the two that are contiguous. Nevertheless, without being able to say when exactly the one ends and the other begins, the ear remarks that a change has taken place, and the mind is excited to attend to this change, and to the anatomical conditions that correspond to it: now, this is all that is required in practice, this is the useful side of the question—this is what we seek. Besides, have we not said, that in the law of coexistence of these different forms of ronchi, in their seat, in the symptoms that accompany them, we have the means of distinguishing them?

1st. The crackling ronchus, during its period of dryness, may be confounded with the pulmonary crumpling sound more easily than with any other; I have already, in speaking of the latter, given their differential diagnosis.

2nd. It is the same with respect to the pleuritic friction sound.

As to the humid crackling ronchus, and the mucous ronchus that succeeds it, we will find in their peculiar seat, in the order in which they appear, in the symptoms that accompany them, the means of distinguishing them. Besides, at the period of the disease that these ronchi exist, phthisis reveals itself by other and well marked signs; and hence the practical object of this work (the prognosis, the diagnosis, and consequently the treatment) will still always be attainable, even though there should be a doubt as to whether we hear the simple mucous ronchus, or the mucous ronchus which is a more advanced form of the humid crackling, and which is the usual prelude to the cavernous and gurgling ronchi*.

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* The ronchus I have described as the *humid crackling*, appears to have been observed by some authors, and noticed by them under different names. M. Andral (Clin. Med. t. 4, 3rd edit. p. 67,) describes it under the general name of *humid ronchi;* he compares it to those of bronchitis. M. Clarke (Traité de la Consomption pulmonaire, p. 38,) says, that in the 2nd stage of phthisis we hear a *crepitant ronchus*, to which he himself in some places gives the name of crackling, so naturally does this word present itself to the mind to express the sensation felt by the ear. M. Hirtz has described it by the name of *cavernulous ronchus.* But the very descriptions these writers give, induce me to think that the ronchi noticed by them, under these different names, belong to a more advanced period of phthisis than that which I call humid crackling. The ronchi they describe correspond rather to that degradation of the humid crackling that I have called *mucous ronchus with a clear* and somewhat metallic *quality*, and which

VI. *Conditions of production of the crackling ronchi.*

Whenever an opportunity offered, I have endeavoured to ascertain the anatomical conditions corresponding to the crackling ronchi. Several patients who have sunk at different periods of the disease, either from the disease itself, or from some other, have afforded me opportunities for these researches. The anatomical conditions on which they depend, may be summed up in the following propositions:

1st. The dry crackling ronchus corresponds to that phasis of the first period of phthisis, which is represented by a simple infiltration of crude tubercles into the pulmonary tissue. The condition of production of this sound, appears to be the presence of a certain number of tubercles, isolated or united in groups in the top of the lung. When only a few very small isolated tubercles are contained in the top of the lung, the dry crackling ronchus does not seem to be produced, except from the reunion of several conditions by no means easily analyzed.

is the prelude to the cavernous ronchus. We have a proof of this in the comparison M. Andral makes between it and the humid ronchi of bronchitis; in the remark of M. Clarke, that it does not appear till the 2nd stage of phthisis; in what M. Hirtz says of his cavernulous ronchus (p. 27. These Inaugurale): "To have an accurate idea of the cavernulous ronchus, we must study it in a case where excavations are on the point of forming; the bubbles being then larger, we will perceive round the commencing cavities the ringing, metallic crackling that characterizes it. It should be sought for chiefly on the scapula and under the clavicles. In thin persons it may often be perceived by the hand." Every thing, it is plain, tends indeed to prove that the humid ronchi, antecedent to the cavernous, described by writers under different names, represent a more advanced period of phthisis than the humid crackling. Thus then, the humid crackling ronchus, and still more, the dry crackling ronchus, enable us to arrive at the diagnosis of phthisis at a much earlier period than the ronchi described by authors. Is further proof necessary? The metallic *quality*, the prelude of the cavernous *quality*, which I have said accompanies the mucous ronchus of phthisis, and which M. Hirtz gives as the distinctive character of his cavernulous ronchus, is not found in the humid crackling; consequently, the cavernulous ronchus of M. Hirtz represents a more advanced period of phthisis than that which I have described by the name of the humid crackling, and corresponds to the ronchus I have called *mucous with metallic quality*. In conclusion, I think the name cavernulous ronchus replaces happily that of mucous ronchus with metallic *quality*. It expresses more concisely and more technically the variety of ronchus that precedes the cavernous. The series of the ronchi of phthisis may then be laid down thus:

1°. Pulmonary crumpling sound, or ronchus.
2°. Dry crackling ronchus.
3°. Humid crackling ronchus.
4°. Cavernulous ronchus (or mucous with clear *quality*).
5°. Cavernous or gurgling ronchus.

The two first belong to that period of phthisis when the tubercles are still in the state of infiltration; the first usually appears earliest in the progress of the disease.

The third manifests itself when the softening of the tubercles is going on.

The fourth, when cavities have formed, but are yet small.

The fifth, when the cavities have attained a greater size.

2nd. The humid crackling ronchus appears to be, in its different phases, the exact symptomatic representative of the process of softening, which gradually pervades the crude tubercles. The more or less rapid progress of this softening, and its actual degree, appear to be expressed with tolerable accuracy by the rapidity with which the crackling ronchus passes to its humid period, by the degree of its humid character, and by its greater or less tendency towards the bubbling form. The tubercular infiltration that produces and accompanies this ronchus is always more marked, more abundant in cases of miliary phthisis, than where the tubercles are large.

3rd. We find the crackling ronchi occur in distant parts of the lungs more frequently in acute than in chronic phthisis. The reason is obvious: in the latter the tubercular infiltration is usually confined to the top of the lung; whereas in the former it generally occupies a greater extent.

4th. The degree of perviousness of the portion of pulmonary tissue that intervenes between the tubercles, is one of the conditions of production of the dry crackling ronchus, and of its different transformations. Indeed, without indulging in conjectures on the mechanism of formation of these ronchi, we may conclude that the degree of force with which a column of air, or a great many small columns, are pushed into the vicinity of the foreign bodies contained in the tissue of the lungs, must have much influence on the degree of intensity of the crackling ronchus and its different transformations.

VIII. *Diagnostic value.*

In conclusion, coming to determine, as the object of this work, the diagnostic and prognostic value of the crackling ronchus, we may lay down as facts sanctioned by experience:

1st. That the crackling ronchi, viewed separately, or in connection with the other ronchi of phthisis, and with the different alterations that may have taken place in the respiratory murmurs, are important signs in the diagnosis and prognosis of that disease.

2nd. That they enable us, by means of the physical characters that belong to them, to determine, in a manner generally exact and precise, the degree of alteration actually existing in the lungs.

3rd. That the dry crackling ronchus corresponds to simple infiltration of crude tubercles.

4th. That the humid crackling ronchus expresses, by its degree of humidity, by its degree of tendency to the bubbling character, the degree and progress of the softening process in the tubercles.

5th. That, viewed in their entire existence, in their connection with each other, or with the other morbid signs of phthisis, these ronchi afford an excellent means of appreciating the general course of the malady, as well as its stationary or progressive state. (20)

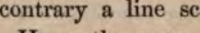
ARTICLE XI.

OF THE HUMID RONCHUS WITH CONTINUOUS BUBBLES.

The lung, like the brain, may become the seat of *active* sanguineous congestion; hence the affection I have described under the name of *active sanguineous congestion of the lungs.* I abstain from entering into details on this subject until I come to speak of the auscultatory signs presented by each of the diseases of the respiratory system (see 1st part, ch. vi. art. 2, sec. 3); for the present, I intend only to describe one of the signs of active sanguineous congestion, that which I have named humid ronchus with continuous bubbles.

All the cases, 23 in number, from which I have collected a detailed account of active sanguineous congestion of the lungs, have presented a peculiar auscultatory sign, deserving the name of ronchus, distinguished by the following characters:

1st. This sound is a humid, bubbling, vesicular ronchus, that is originating apparently in the vesicular section of the respiratory apparatus, and giving to the ear the sensation of bubbles which arise, become developed, and are accompanied with a peculiar character of humidity. These two sensations are perfectly distinct; they are constant, and have besides a special character, which completely distinguishes them from sensations nearly similar produced in other circumstances.

2nd. With the humid character of these bubbles is combined a character of *viscidity*, which leaves on the ear an impression of slow, difficult, and especially of imperfect developement: in fact, these bubbles never attain, as those of other ronchi do, a complete spherical form; they never reach more than one-third, or one-half, perhaps, of their developement, and it is distinctly felt that this is owing to the viscid quality of the liquid that forms them. Each bubble succeeds the preceding one, before the latter is rounded and perfectly developed; and so continually. Hence it follows that the series of bubbles composing a period of this ronchus, instead of representing a well marked festooned line, each festoon corresponding to a bubble of the ronchus , as in the other mucous ronchi, represents on the contrary a line scarcely festooned, almost straight . Hence the name continuous given to these bubbles. Hence the expression humid ronchus with continuous bubbles, an expression which represents with tolerable accuracy the impression made on the ear.

3rd. These bubbles are somewhat more voluminous than those of the primary crepitating ronchus of pneumonia, and less voluminous than those of the common mucous ronchus (humid bronchial), or of the secondary crepitating ronchus of pneumonia, at an advanced period of the *resolution of hepatization.*

4th. Their number is not considerable: 3 or 4 only in each inspiratory movement.

5th. They are not very uniform, compared with those of the primary crepitating ronchus of pneumonia, but they are tolerably so, compared with those of the mucous ronchus.

6th. Their form is flattened rather than round: such, at least, is the impression made on the ear, and which is in accordance with their incomplete spherical developement.

7th. They are produced slowly: which seems to depend on the viscidity of the liquid with which the lung is gorged. This slowness in their developement strikingly distinguishes them from the bubbles of the primary crepitating ronchus of pneumonia, which, on the contrary, as is well known, succeed each other in puffs and with precipitation.

8th. The essential character of the humid ronchus with continuous bubbles is, that it is constant, and coexists exclusively with inspiration. It is towards the termination of this movement it is heard.

9th. In general it is more marked in proportion as the patient inspires more strongly. Its diagnostic value in active sanguineous pulmonary congestion is very great, for I do not recollect having ever met it in any other disease.

10th. From the delicacy of its sound, it is not audible beyond the limits of the congestion that produces it. Its site is variable, like that of the affection on which it depends.

11th. It presents but few varieties: it is only a little more or less marked; its bubbles a little more or less humid, with a character of continuousness more or less striking, according to the degree of the disease.

The ronchi with which it may be confounded are the following:

The primary and secondary crepitating ronchi of pneumonia, the sub-crepitant ronchus of œdema of the lungs, and the sub-crepitant ronchus of acute capillary bronchitis.

1st. It is, in general, distinguished from them all, by the continuous and viscid character of its bubbles, by their slow, and, as it were, difficult developement.

2nd. It is distinguished from the primary crepitating ronchus of pneumonia, by the greater number of bubbles in the latter, their perfect sphericity, their precipitate formation, and their production in puffs; by the almost complete want of the sensation of humidity in them, while this sensation is inherent in the ronchus of congestion; by the signs that accompany the pneumonic ronchus, especially dullness on percussion and bronchial respiration.

3rd. It is distinguished from the secondary crepitating ronchus of pneumonia, chiefly by the progress of the latter, by the circumstances in which it originates, by the last signs of pneumonia which still remain; lastly, by the greater size and more complete separation of the bubbles.

4th. The sub-crepitant ronchus of œdema of the lung is distinguished from it by the complete absence of the sensation of viscidity; by the greater sphericity and separation of the bubbles; by the absence of all the symptoms of sanguineous plethora and general excitement, or even very often by the opposite state, serous plethora, anasarca, and general anemia.

5th. The sub-crepitant ronchus of acute capillary bronchitis is composed of larger bubbles; these bubbles, in number, sphericity, and rapidity of production, resemble in some degree those of the primary crepitating ronchus of pneumonia; it exists over a great extent; it always occupies the posterior part of both sides of the chest, while the ronchus of congestion is usually confined to one. The ronchus of bronchitis is, moreover, accompanied with much cough, with sibilant and sonorous ronchi in some points, and with much fever; circumstances that are all wanting in simple sanguineous congestion.

The humid ronchus with continuous bubbles has three periods: its period of commencement, in which it is little marked, and is in some degree merely an exaggeration of the humid character; its perfect state, in which it presents the characters just described; its period of resolution, during which the bubbles become a little more voluminous, more rare, and more humid.

The ronchus I have described is the principal sign of active sanguineous congestion of the lungs. It is to this affection what the crepitating ronchus is to pneumonia. At the same time the coexistence of the other signs of congestion is, in general, necessary to determine the diagnosis; for example, the coexistence of diminution and of humidity of the respiratory sounds. But these signs so constantly accompany the former, at least in all the cases I have observed, that doubt will seldom arise, provided we follow in the application and analysis of auscultation, the course I have developed in this work. (21)

ARTICLE XII.

OF THE PLEURITIC FRICTION SOUNDS.

Different writers, and particularly M. Renaud, have treated with great ability of the pleuritic friction sounds. It is not, therefore, my intention to take up the history of these sounds here, but merely to direct attention to some points that seem to require notice, and to the practical conclusions that may be derived from them.

1st. At page 68, I have proved, by experiments on animals: 1°. That in the normal state the lung, during both inspiration and expiration, performs a locomotive movement upon the surface of the costal pleura; 2°. That this movement is not accompanied by any appreciable sound. M. Andral had long before determined the same fact by experiments on horses. Auscultation practised on healthy persons, of all ages and constitutions, gives the same negative result.

If we suppose, as reason and analogy suggest, that there is a correspondence between the extent of locomotion of the lungs and the volume of the thoracic organs, we must conclude that in man, in whom the thoracic organs are much more developed than in the rabbit, the extent of the locomotion of the lung, and the friction between the pleuræ, is much more considerable than in that animal, and consequently much more than an inch. Now, we shall hereafter see this proposition confirmed by the morbid circumstances we shall have to analyze.

The friction, which in the normal state is noiseless, is accompanied with sound, when the natural lubricity and smoothness of the corresponding pleuræ happen to be changed.

2nd. The sounds that originate at the surface of the pleuræ have all the common character of leaving on the ear that hears them, on the hand that feels them, a sensation of *friction*, of the motion in different directions of two dry or irregular surfaces. They are composed of successive jerks, whose number, which never exceeds 5, is directly proportional to the extent of surface engaged. Their duration is measured by the number of these jerks, and hence affords an accurate means of judging of the extent of the rubbing surface; sometimes it is a small point on the surface of the lung, which passes as a tangent over the parietal pleura, and then the sound is brief and rapid; at other times the extent of surface is considerable, and its contact prolonged, and then the sound is more slow, more elongated, composed of a greater number of jerks. The extent of the rubbing surface, and consequently the duration of the sound, are directly proportional to the degree of dilatation of the lung, that is, to the permeability of its cells, and to the degree of force with which the patient produces the respiratory motions. The intensity of the friction sounds is proportional to the degree of developement of the anatomical causes that produce them, and to the force with which the two dry or uneven surfaces are pushed against each other. Three degrees in particular of this intensity have been recognised, as representing three anatomical degrees or forms: 1°. the *grazing* sound (bruit de *frolement*); 2°. the *friction* sound properly so called (bruit de *frottement*); 3°. the *rasping* sound (bruit de *raclement*). Setting aside the dynamic influence common to the intensity and duration, it may be said, speaking generally, that the duration of the pleuritic friction sounds represents the state of the lung (the degree of permeability of its cells), and their intensity, the state of the pleura (the dryness or roughness of its surface). We will see hereafter what practical inductions may be drawn from these circumstances.

3rd. We feel distinctly, in listening to the pleuritic friction sounds, that they are generated immediately beneath the ear, quite superficially, and not, as in the case of most other sounds, deep in the chest.

4th. The pleuritic friction sounds ought to be analysed separately in inspiration and expiration, for they do not necessarily coexist with both periods of respiration. The general principle that governs them in this respect is the following: 1°. they are always heard during inspiration; they are not audible in expiration, except when they have a certain degree of force, a certain duration, and a defined form; at the grazing degree no trace of them is perceived in expiration; the friction sound, properly so called, is usually audible in both periods of respiration; and *a fortiori*, the rasping sound. There are, however, exceptions to this general principle: in one of my cases, the grazing sound was heard both in inspiration and expiration; and in another, the rasping sound was confined to inspiration alone. 2°. they are always more marked during inspiration; the jerks of which they are composed are somewhat more numerous during this period; this is what we should expect, inasmuch as the locomotion of the lung and the dynamic effort are more considerable during this period of respiration; the difference is more striking in proportion as the friction sounds are more feeble.

5th. The pleuritic friction sounds give the sensation of a successive developement from below upwards in inspiration, and from above downwards in expiration. This fact implies a contradiction to the experiments on animals, reported at page 68; for in them the lung was seen to move from above downwards in inspiration, and from below upwards in expiration. I shall not attempt to explain this opposition between two facts, satisfied with having established them.

6th. In the great majority of cases, the sound of pleuritic friction is accompanied with a sensation of dryness; but, in some instances, it leaves an impression of humidity. In one of my cases it assumed this form; and there it depended on the soft and humid state of the rubbing surfaces*. But these two conditions are necessary: for if the false membranes are very dense, very firm at the surface, though bathed in liquid, the friction sound preserves its dry character. Such indeed were the anatomical and symptomatic characters presented in a patient who died August 18th, 1836, at No. 18 ward of St. Raphael, hospital of La Pitie.

7th. The usual seat, and in general the place of maximum intensity of the sound of pleuritic friction, is the postero-inferior region of the chest; but a fact less known, and of some importance as a rational sign of tubercular infiltration of the lung, a fact which several of my cases confirm, is that the grazing sound is remarkable for the variability and the changeability of its situation, which is in the superior rather than the inferior parts of the chest. Being in general the result of partial pleurisies of small extent, which very often depend on eccentric tuberculization of the lungs, it of course is found wherever this occurs, that is, in various points, but rather near the top than the base of the lung. The grazing sound resulting from this cause is usually confined to a very small space, while that which depends on simple pleurisy (which M. Reynaud has described under the name of dry pleurisy) is heard over a much greater surface. (22)

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* It was, of course, by examination after death that this was established. (Hospital de la Charite, ward St. Louis, No. 24.)

8th. We must not always consider the space over which this sound is heard, a measure of the extent of surface affected, for in three of my cases the sound was propagated beyond this limit. In such cases we find, that it loses its intensity in proportion as we recede from the place it originates, and that instead of ceasing abruptly, as is sometimes the case, it diminishes and ceases by insensible shades. In one of the three cases to which I have just referred, we heard the friction sound in the inferior two-thirds of one side of the chest, and yet the autopsy shewed that the rubbing surface did not exceed two square inches.

9th. It is in general a favourable sign to see the pleuritic friction sound occupy a large surface, because this indicates a rapid and uniform absorption of the effusion.

10th. The pleuritic friction may be appreciated by auscultation, by touch, and by the sensations of the patient. But it is not appreciable by the two latter means, except in some of its forms and at certain degrees of intensity. The general principle on this subject is the following: the touch and the sensations of the patient are less applicable to the analysis of this phenomenon, in proportion as the degree of its intensity and form is lower. In its first degree they are altogether inapplicable.

11th. Laennec has described, as a pathognomonic sign of interlobular emphysema of the lungs, an *ascending* and *descending* friction sound: the first, he says, accompanying inspiration; the second expiration[*]. He attributes this phenomenon to the rubbing against the costal pleura of the moveable projecting bubbles of air, which, in this disease, elevate the pleura of the lungs. But we do not find, in Laennec's work, any anatomical confirmation of this relation of cause and effect, assigned by him to the bubbles of emphysema, and the sound he describes as their sign. On the contrary, he says in another place[†], "that he never saw a person die of interlobular emphysema." The only two cases he has given[‡] are of patients who were cured, and who, as M. Meriadec Laennec has remarked[§], were at the same time affected with well marked pleurisy, diagnosed as such by Laennec himself. In the case shewn to him by M. Honore in 1824, in which this ascending and descending friction sound existed, and from which this doctrine of Laennec originated, there was also pleurisy with effusion: Laennec himself remarks[‖] that the respiratory murmur was almost extinct in the side where the effusion had existed. In another part of his work[¶], he says also he never saw interlobular emphysema and vesicular emphysema coexist in the same lung; consequently he could not have made use of this circumstance, to establish the relation of cause and effect between the two facts referred to above, which he admits he was never able to establish directly. The friction sound he has described as belonging to emphysema is besides quite that of pleurisy: like it, it has the ascending character in inspiration, the descending in expiration; like it, it is superficial, it is produced during strong inspirations only; lastly, like it, it is appreciable by the sensations of the patient, by touch and by auscultation*. The progress of the phenomenon is the same in both cases. In the supposed cases of interlobular emphysema, quoted by Laennec, the patients were all cured; now we know that pleurisy, in the state in which the friction sound is present, always ends in resolution, and that it is the reverse in emphysema. Laennec† says he observed the signs he attributes to emphysema, in 12 or 15 other cases besides those he relates; now all know how rare real lobular emphysema is, and how frequent pleurisy.

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[*] Auscultation Mediate, edit. de M. Andral, t. 1, p. 411. Forbes's Translation, p. 175.

[†] Ibid. p. 413. Ibid. p. 176.

[‡] Ibid. p. 414. Ibid. p. 176.

[§] Ibid. p. 418.

[‖] Ibid. p. 144. Ibid. p. 61.

[¶] Ibid. p. 410. Ibid. p. 175.

Lastly, Laennec concludes‡ "that the friction of ascent and descent depends, at least in most cases, on interlobular emphysema of the lung: it is, he says, with the dry crepitant ronchus with large bubbles, quite pathognomonic of this affection."

Since Laennec, many other practised auscultators, of whom I shall only mention M. Andral and M. Louis§, have seen the different forms of emphysema, both before and after death, and no one has met the sign described by Laennec. I have in the hospitals noted carefully many cases of pulmonary emphysema; I have often, after death, found bubbles of air on the surface of the lung, elevating the pleura, some moveable, others not; and yet the most delicate examination during life had never in these cases detected a trace of this sign.

From all this, it is plain that Laennec must have mistaken pleurisies in a state of resolution for interlobular emphysema of the lungs; or that indeed, seduced perhaps by the specious analogy between the anatomical conditions in the two cases, he admitted, *a priori*, the friction sound heard in pleurisy as a sign of interlobular emphysema, forgetting, under the influence of this impression, the necessity of direct observation. The respect I feel for the opinions of Laennec, even when I differ from him, a respect that induces me to go at length into the proofs of my own views on the subject, will, I hope, be considered sufficient excuse for the length of this discussion. (23)

Let us then give up emphysema as a cause of the friction sound, and conclude that pleurisy, of longer or shorter standing, can alone, as far as we at present know, produce this phenomenon.

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* Auscultation Mediate, edit. de M. Andral, t. 1, p. 144. Forbes's Translation, p. 61.

† Ibid. p. 145. Ibid. p. 61.

‡ Ibid. p. 415. Ibid. p. 61.

§ In his excellent Memoir on pulmonary emphysema (Memoires de la Soc. Med. d'Observ.), M. Louis even considers it out of place to speak of the friction sound of ascent and descent.

12th. There is, in general, a complete correspondence between the intensity and duration of the sound in question, and the duration, the extent, and the severity of the pleurisy that produced it. However, we find instances of recent acute pleurisy accompanied by friction sound in its third degree.

13th. Pleurisy is a very common disease; the pleuritic friction sound is rather rare; and yet most pleurisies terminate by resolution, and follow a course apparently favourable to the developement of this phenomenon. Whence, then, this difference as to frequency of cause and effect? 1°. When there is nearly complete and regular adhesion between the two pleural surfaces, the friction sound cannot be produced, on account of the obstruction thus given to the locomotion of the lung. 2°. When, in *pleuropneumonia*, the congestion of the lung is so great and so extensive as to prevent its locomotive expansion, and that resolution of the pleurisy takes place sooner than that of the pneumonia, the friction sound cannot occur. Lastly, we can easily comprehend that it may not be noticed in many cases, either because the sound is very feeble, or that it occupies only some small points of the chest, which have not been examined, or that there have been too long intervals between the examinations. But besides the causes which I have assigned to account for the absence of the pleuritic friction sound, there are cases in which the elements of this problem of simple physics are so complex, that it seems impossible to determine the precise cause.

14th. I find in my observations of pleuritic friction sound, a considerable number of relapses in pleurisy: in such circumstances, as is well known, new layers of false membrane are deposited on the old, and this, above all other things, must produce inequality and roughness of these membranes; and so it was in those cases particularly I met the most intense forms of the friction sound.

15th. We always find some trace of the respiratory murmurs coexisting with the friction sounds, because the locomotive expansion of the lung and the rubbing that results from it cannot be produced without the penetration of some air into the vesicles. But, in general, we observe the respiratory murmurs decrease in proportion as the friction sound attains a higher form. The sound on percussion, the vibration of the voice, and the motions of the chest, follow the same law. (24)

16th. It may be said, in general, that the pleuritic friction sound indicates an affection of shorter or longer standing, according as it is weaker or stronger. But there are many exceptions to this rule.

17th. The natural course of the friction sound is, that it is at first feeble; then it augments in extent and in intensity, and then diminishes and disappears. It always appears first, and disappears last, in inspiration. I was able to follow this progress perfectly in one of the two cases of empyema in which I operated: in proportion as, by the more complete evacuation of the liquid, the contact of the lung and costal pleura became more immediate and extensive, the friction sound, appearing first in inspiration, and extending afterwards to expiration, increased in duration and intensity.

18th. The persistance of the friction sound is usually proportional to its intensity, to the slowness with which it manifests itself, and to the chronic character of the pleurisy that produces it. The diagnostic consequences deducible from it are very simple. The grazing sound, which I have already referred to partial pleurisy depending on eccentric tuberculization, is characterized by a duration so ephemeral, that it may complete its course in a single day, and may thus in a few days appear and disappear so often as four times. Such, at least, is the result of some of my observations. The sudden disappearance of the friction sound may depend on the return of the effusion, or on the supervention of pneumonia, which prevents the locomotive expansion of the lung.

19th. My observations prove, that a blister applied over the part where the friction sound is audible hastens its disappearance. One case is peculiarly remarkable in this respect: two blisters were applied in succession; each time during the period of suppuration the friction sound disappeared, each time it reappeared as soon as the part dried up. The care with which auscultation was practised in this instance left no room for doubt.

20th. The friction sound is not produced unless two quite distinct and independent conditions are present: 1°, a certain state of dryness and unevenness of the pleuræ; 2°, a locomotive movement effected by these surfaces.

21st. The anatomical conditions of pleuritic friction sound are well known. I will only state in reference to this some facts which do not agree with the general laws that have been laid down on the subject. 1°. In one of my cases, the only irregularity found on the surface of the false membrane consisted of an infinite number of small tubercular granulations, infiltrated into the false membrane, and projecting above its surface by a small segment only of their circumference. The granulations did not exceed in size the head of a small pin, and yet the friction sound was of the third degree. 2°. A small quantity of fluid, about a spoonful, effused into the pleura in one of my cases, produced no sensible diminution in the intensity of the sound, but communicated to it a peculiar humid character. 3°. In another case an *abundant* effusion existed, and yet the friction sound was not the less audible; but some bands of adhesion retained part of the lung in rather close contact with the costal pleura.

22nd. The physiological causes of the pleuritic friction sounds have been less investigated than the anatomical. They consist in the degree of locomotive expansion of which the lung is susceptible. They exercise considerable influence on the period of appearance, the course, the extent, and the degree of intensity of the sounds. Upon them rests the principle formerly laid down: that, in the first period of the existence of a friction sound, there exists a direct ratio between its degree and the cipher of inspiration.

It is under the influence of this class of causes that we sometimes see the appearance of the friction sound coincide, not with the period of the resolution of the pleurisy, but with the period when the resolution of a coexisting pneumonia has taken place, and when the respiratory expansion begins to reappear. It is under this influence that the friction sound increases in extent, in proportion as the extent of the hepatization diminishes. It is this makes the sound gradually disappear, when pneumonia supervenes in such circumstances. It is by this also that, without any change in the anatomical conditions, an intense friction sound ceases to be audible in the last hours of life, when inspiration can do no more than push the air into the first or second divisions of the bronchi. These propositions are but a summary of so many particular observations. Thus, two elements compose the physiological condition of the friction sound: 1°. the degree of force with which the patient respires; 2°. the degree of permeability of the lung. In certain anatomical conditions, a very small extent of motion is sufficient for the production of this sound. In one of my patients it existed in its highest degree, and yet after death, on blowing into the bronchial tube of the lobe where the sound was heard, with more force certainly than the ordinary inspiration of the patient, we could not produce a greater dilatation than 8 lines in the circumference of the lung. One of my cases also shews, that the adhesion of a part of the lung does not prevent its locomotive dilatation and the developement of friction sound in the rest of its extent. This fact is a consequence of the preceding one.

23rd. The problem of the sound of pleuritic friction comprehends these three principal elements: 1°. the anatomical state of the surfaces; 2°. the relation of these surfaces to each other; 3°. the degree of motion with which they are impelled against each other. These elements, variously combined, account for all the phenomena produced, and the circumstances by which they are accompanied. It is the delicate analysis of each of these elements, of their possible combinations, and of the relation existing between these different combinations and the symptomatic phenomena observed, that gives the practitioner the power of ascending from the effect to the cause, and of thus determining from such or such an assemblage of symptoms, the anatomical and physiological conditions of the affected organs. Such is, in a word, the object of the researches I have detailed. I have already, in stating the facts, anticipated some of the practical applications of which these researches are susceptible; the analysis of my cases shews some others that may be useful in practice. Thus:

24th. The grazing sound, when it is fugitive and of small extent, when within a short space of time it often reappears in different points of the chest, especially about the superior regions, may become a sign of pulmonary phthisis. In some cases, in fact, the tubercles are developed at the circumference rather than the centre of the organ, and excite here and there partial pleurisies, before they manifest themselves by the usual signs. But most frequently, the disease is already obvious enough when the partial pleurisies occur, and then the whole value of the friction sound lies in shewing the progressive increase and the spreading of the tubercles from the centre to the circumference.

25th. A friction sound diminishing and suddenly disappearing, at the same time that the respiratory murmurs diminish and disappear also, is a sign of pneumonia or of the renewal of the pleurisy. These circumstances made me suspect pneumonia in one of my cases, and this suspicion was confirmed by the local signs that afterwards appeared.

26th. The locomotive expansion of the lungs is sensible in all parts of the chest, since the friction sound is heard every where. But clinical as well as direct observation proves, that this movement is more developed in proportion as we descend to the inferior parts of the chest.

27th. In some cases of operation for empyema, and in a great number of cases of pleurisy, the friction sound shews by its appearance, the contact that has taken place between the two surfaces of the pleura; it shews the extent of this contact, and the size the lung, long compressed by the effusion, has attained. In one of my cases this sign was more faithful than auscultation and percussion; the lung had resumed its contact with the ribs, but its external layer being considerably indurated, there was, in consequence, much dullness of sound and marked diminution of the respiratory murmurs in that side of the chest; and these two circumstances led to the erroneous notion that the lung was still maintained at a distance from the ribs by a layer of liquid.

28th. The preceding case proves, that the locomotive expansion of the lung is not so much impeded by condensation of its outer layers, as by false membranes of the same thickness; for the friction sound is never produced when a thick false membrane embraces the lung: the reason is, that in the one case the volume of the lung is diminished, in the other it remains unchanged.

29th. If we have dullness on percussion, and some dilatation of the side where the friction sound is heard, there is considerable effusion into the pleura, and a portion of the lung is retained in contact with the side by bands of membranous adhesion. The pulmonary expansion that takes place under these circumstances, is a proof that the expansive force of the lung exceeds the pressure of even a considerable effusion. Let me again observe, that these propositions are a summary of some of the facts I have observed on this subject.

30th. When a friction sound, appearing in the course of a pleurisy with effusion, acquires in a uniform and rapid manner, over an extensive surface, considerable intensity, it is a proof that the resolution of the effusion is taking place freely and rapidly—it is a good sign; and if, after having attained its maximum, it follows in its decrease the progress I have traced, it is a further proof that the resolution of the pleurisy continues to follow a uniform and free course, and that we have not to fear the slow, irregular, interrupted resolution we sometimes meet.

ARTICLE XIII.

REMARKS ON SOME OF THE RONCHI DESCRIBED BY LAENNEC.

I. *Humid crepitant vesicular ronchi.*

There are a number of ronchi that appear to be formed in the air cells themselves, and to depend on the different states of engorgement that occur in these cells. Some persons consider these different crepitations as so much alike, that they can only be considered as signs common to all the organic alterations that produce them. Writers do not allow more value to the crepitant ronchus described by Laennec as pathognomonic of pneumonia. Others, on the contrary, have endeavoured to determine constant, or nearly constant differential characters between these ronchi, to ascertain the relations that connect these characters with the differences that exist between the various organic states in which these ronchi are met, and to attach each as its sign to that organic alteration with which it is most frequently found to coexist. I think with the latter, that if we confound under the general term crepitant, the different vesicular ronchi, and see no sensible difference between them, it arises for the most part from our neglecting to seek for those differences, or from not seeking for them in circumstances calculated to furnish them. The authors of the Compendium de Medecine pratique* foresaw what must happen, when they said: "We think, from the progress every day made in the mode of observing diseases, that the number of ronchi now admitted will hereafter be increased."

I believe, that in the actual state of science, we may admit as distinct the following varieties of vesicular ronchi:

1°. The humid ronchus with continuous bubbles of active sanguineous congestion of the lungs.

2°. The sub-crepitant ronchus of œdema of the lungs.

3°. The sub-crepitant ronchus of acute capillary bronchitis.

4°. The crepitant ronchus redux of pneumonia.

5°. The primary crepitant ronchus of pneumonia.

I have already given the differential characters of the humid ronchus with continuous bubbles.

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* Vol. 1, page 480.

1st. The sub-crepitant ronchus of œdema is distinguished: 1°. from the primary crepitant ronchus of pneumonia, by its bubbles, which are more voluminous, fewer in number, more humid, much less close to each other, less uniform in size, less regularly rounded; by its existence in the postero-inferior regions on both sides of the chest, whereas the pneumonic ronchus scarcely ever exists in more than one side; by the absence of the symptoms of pneumonia, local and general; by the existence of general serous infiltration, which most frequently coincides with pulmonary œdema; by its rapid change of situation, in passive œdema, according to the position the patient takes. 2°. It is more difficult to distinguish it from the ronchus redux of pneumonia, because we often see pneumonia towards the termination of its resolution, end in œdema of the lung. At the same time we can, in general, distinguish them in this way: that the ronchus redux exists in one side only of the chest; that it succeeds to the signs of pneumonia, and that some of them often coexist with it, such as a shade of bronchial character, and rusty coloured sputa; that it resembles more in its physical characters, the primary pneumonic ronchus, than the crepitant ronchus of œdema. 3°. The ronchus of acute bronchitis and the ronchus of œdema agree as to their site; both usually occupy the postero-inferior parts of the chest. But they differ in other respects: the bronchitic ronchus resembles, in its physical characters, the ronchus of pneumonia much more than that of œdema; its bubbles are dryer, more regular, more closely approximated, more numerous, more rapid in their developement; besides, with the bronchitic ronchus there is either no expectoration, or it is of a viscid character, and not the watery expectoration of œdema; there is cough, fever, and in general sonorous and sibilant ronchi, which occupy the superior parts of the chest, especially in front.

2nd. There is something so peculiar in the crepitant ronchus of pneumonia, in its fine, dry, regularly rounded, uniform bubbles, closely approximated to each other, and decrepitating in rapid puffs beneath the ear during inspiration, that I do not think there is any known ronchus that can perfectly simulate this assemblage of characters, when they exist in the marked form I have just described; accordingly, in such circumstances, the crepitant ronchus ought, in my opinion, be considered pathognomonic of pneumonia; but it does not always present itself in this well marked form. 1°. In this case the ronchus of acute bronchitis is that with which it may be most easily confounded. The best distinctive character between them* is, that the pneumonic ronchus scarcely ever exists in more than one side of the chest, whereas the bronchitic invariably occupies both; moreover, the exclusive seat of the latter is the postero-inferior regions, while the seat of the ronchus of pneumonia is as variable as that of the disease. We will usually have in the coexistence of the signs of bronchitis or the signs of pneumonia, other means of

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[*] *Character* given by M. Louis, Clinique Medic. de la Pitie, 1836.

establishing the differential diagnosis of these two ronchi. 2°. The bubbles of the ronchus redux are in general more voluminous, more irregular, more humid, more slowly formed, less numerous, and in particular less produced in puffs, than those of the primary ronchus of pneumonia. Moreover, they coexist less exclusively with inspiration; frequently they are only heard when the patient makes a deep inspiration, and cease to appear in the ordinary inspirations that follow.

3rd. The ronchus of acute bronchitis, is distinguished from the ronchus redux, by the same characters that distinguish it from the primary ronchus of pneumonia.

Such are the differential characters of the vesicular ronchi. In their typical forms these ronchi may always be distinguished. When they are less marked, we may still, most frequently, arrive at their differential diagnosis by an exact analysis of their different characters; it is however true, that like other morbid phenomena, they may undergo such degradations from their normal type, that they approximate so closely to one another as to be no longer distinguishable. This is observed when several of the organic alterations with which the ronchi correspond exist at once in the same lung; in such cases the diagnosis derived from all the other signs is as obscure as from the ronchi.

A ronchus with bubbles somewhat humid, tolerably fine, tolerably regular, and usually not numerous, sometimes appears after pneumonia in the posterior inferior parts of both lungs. It is only heard in the first deep inspiration we make the patient take; after which, in whatever way he inspires, it is no longer audible. This ronchus appears to depend on the state of sanguineous and serous engorgement that occurs in the depending parts of the lungs, at the period of resolution of some pneumonias. It is the same ronchus that is produced in the pulmonary engorgements that accompany diseases of the heart; only in the latter case its bubbles are larger, more humid, and less regular; moreover it persists a very long time, and may disappear and reappear frequently, according to the state of the pulmonary circulation.

It is now well ascertained, contrary to the opinion of Laennec, that in central pneumonia, the most careful auscultation cannot recognise any of the usual local signs of the disease. During the year 1837, there were three patients under the care of M. Andral at la Charite, who were affected with central pneumonia, characterized by the sputa and the general symptoms, in all of whom the above was true.

Some patients in whom I have traced, with the utmost care, and as I may say from hour to hour, the progress of a pneumonia, that I had seen arise under my own eyes, have had no primary crepitating ronchus at the commencement of the disease, and no ronchus redux at the period of resolution. Perhaps this usually occurs when the primary ronchus is wanting.

Extreme debility in the patient, by diminishing very much the extent of inspiration, may prevent the occurrence of the crepitant ronchus of pneumonia, although the lung be in a favourable state for its production.

It results from some cases of pneumonia which I observed at la Pitie and la Charite, that the primary crepitant ronchus is dryer, its bubbles finer, more closely compressed together and generated in larger puffs, in proportion as the attack has been more sudden, and the course of the disease more rapid.

A patient died very rapidly of pneumonia at No. 10 ward of St. Louis. All the usual symptoms appeared in succession ; the disease passed to the third stage, and then we heard in the part of the lung in which the autopsy revealed diffuse suppuration, a mucous ronchus with large humid bubbles, the peculiar character of which was that it was only produced in inspiration. I have since had an opportunity of observing the same fact in another case. The absence of all bronchitic complication in those cases, leaving no ground for supposing that this was a mere ordinary mucous ronchus, gives to those facts considerable value. If indeed, it be determined by farther observation, that at the period of suppuration in pneumonia, a mucous ronchus, coexisting with inspiration only is produced, the fact will be the more valuable, inasmuch as we have at present no certain sign to indicate the passage of pneumonia from the second to the third stage.

II. Laennec considered a ronchus, which he called dry crepitant with large bubbles, as a pathognomonic sign of interlobular emphysema of the lungs.* It is the same of this ronchus as of the friction of ascent and descent, which he also regarded as pathognomonic of that disease ; neither the one nor the other belongs properly to it : one is the pleuritic friction sound and belongs to the history of pleurisy ; the other, as M. Louis has observed† is but the ronchus of bronchitis, and belongs to the history of that disease. Let us see how M. Louis expresses himself on this subject ; "But the reader, if he keep in view the facts that have been just detailed, that in the cases I have carefully studied, the subcrepitant ronchus of emphysema, was the same, following the same laws, and observed in the same parts as that which occurs in severe acute bronchitis, will reject the assertion of Laennec, that it is never heard except in those parts of the chest where the emphysema has attained its maximum."‡ Supposing besides that Laennec was not led astray by the ronchus that M. Louis describes, a supposition scarcely admissible, as he was ignorant of the existence of this ronchus ; supposing that he has described, in the dry crepitant ronchus with large bubbles, a peculiar sound, we are still justified in thinking he was mistaken, since the most practised auscultators have been unable to find this ronchus. M. Andral and Louis deny its existence, and if I am rightly informed, Bouillaud, Chomel, Rostan, &c., do the same. (25)

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* Auscult. Med. ; edit. de M. Andral, t. 1, p. 145. Forbes' translation, p. 163.

† Dict. de Med., 2d Ed. t. 2, p. 334.

‡ Mémoire sur l'Emphyseme, par M. Louis, dans les Memoires de la Societe Med. d'Obs. page 215.

It is stated in the Compendium de Medecine Pratique,* that the *mucous ronchus,* amongst other morbid states, belongs to pulmonary œdema. I think this is a mistake, and that the real mucous ronchus, that is, a ronchus with bubbles somewhat voluminous, very humid, completely developed, and coexisting with both inspiration and expiration, is not produced in real œdema of the lungs.

In all cases where we have reason to think that a certain quantity of any liquid occupies the trachea-bronchial system, if we place our ear near the patient's mouth, we hear a bubbling humid ronchus, which at once reminds us of the slight crepitation which is produced on the surface of a frothing liquor, as a glass of beer or champagne. It seems as if these bubbles were very slender, very delicate, and, as if formed in a very thin liquid, they were developed with the greatest facility. They may be more or less voluminous, and more or less humid, but they do not depart much from the preceding description. When we hear this ronchus in a number of cases, we observe that the bubbles that compose it are not always formed at the same depth; sometimes they seem to come from the pharynx, sometimes from the larynx, from the trachea, or even from the bronchi. The ear, in general, judges accurately enough as to the distance of the place where they originate. We may estimate the quantity of liquid with which the trachea-bronchial system is gorged by the more or less marked character of the ronchus; thus it is more striking in proportion as the patient is more near a state of asphyxia. It is heard both in inspiration and expiration, but chiefly in inspiration. M. Piorry was the first I believe to call attention to it.†

There is much difference of opinion as to the value of the cavernous ronchus as a sign of phthisis in the 3d stage. M. Andral, who has particularly studied this sign, places but moderate confidence in it. "In my opinion," says he,‡ "there is no ronchus produced in a tubercular excavation which may not be equally met with in the bronchi." M. Louis,§ and the authors of the Compendium de Medecine Pratique,‖ cite cases of dilatation of the bronchi in which the cavernous ronchus was heard. I have myself seen all the signs of the most extensive excavations in a patient that died at no. 26, St. Martha's Ward, (Hospital of la Charite,) and who, on examination after death, presented nothing but dilatation of the more superficial bronchi, but to such an extent, that even at the surface of the lung, beneath the pleura, one of them was an inch in circumference. As this enormous dilatation and the signs that corresponded to it existed at the base of the lung, the idea of a tubercular cavity in this case scarcely arrested our attention. M. Hirtz, on the contrary, places more reliance on the cavernous ronchus than on any other sign of the third stage of phthisis. "It ought to be considered, says he*, as the pathognomonic sign of the third stage." "As long as it is not recognized, we have no right to admit the existence of cavities, though the patient present in other respects all the physical signs united of this state of the lung"†. We may think, with M. Hirtz, that the cavernous ronchus, taken separately, is of more value than pectoriloquy, and even than cavernous respiration, inasmuch as bronchophony and the bronchial character, in some cases, approximate closely to these phenomena; but we cannot admit with him, that the diagnosis of a cavity ought to be deemed doubtful, as long as the cavernous ronchus has not been heard, when all the other physical signs are combined to sustain it. We know, in fact, that certain circumstances, such as extreme emptiness or fullness of the cavity, prevent the production of gargouillement. Again, the diagnostic value of the cavernous ronchus ought, in my mind, be restricted to cases where it shews itself in the regions in which tubercular cavities are usually formed, and where the state of the patient's constitution and health warrant the idea of phthisis in its third stage. If these conditions do not exist, it is only in cases in which all the physical signs of an excavation of the lung are found united, that we can admit the existence of a non-tuberculous cavity, independent of dilated bronchi. While I am on this subject, I may remark, *en passant,* after the observations of M. Delaberge‡ that the cracked-pot sound (bruit de pot félé) considered as a sign of the third stage of phthisis, is of no value, unless it be associated with marked dullness of sound on slight percussion.

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* Vol. 1, p. 482.

† Traite de Diagnostic, v. 1.

§ Recherches sur la Phthisie, p. 235.

‡ Clinique Med. 3d Ed. t. 4. p. 75.

‖ Tome 1, p. 485.

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* These inaugural, p. 41. † Ibid. p. 42.

‡ Journal de Connaissances Medico-chirurgicales, No. 3 de Sep. 1837, p. 91 a 92.

CHAPTER III.

COURSE AND CONNEXION OF THE SONOROUS PHENOMENA; THEIR RELATIVE VALUE, THEIR VARIOUS COMBINATIONS.

The different sonorous phenomena, physiological and morbid, of the respiratory apparatus, which we have passed in review, are subject in their general progress, and even in some of their varieties, to laws nearly constant. These laws are derived from the discovery of the relations that exist between the symptomatology and pathological anatomy. The physician, who is master of these relations and the laws derived from them, knows beforehand, if I may say so, all the resources of the disease he has to encounter. He is at each instant aware of all its movements, and of all its tendencies; he can oppose them even before they are developed. If he is called to the patient, when the disease has already gone through a part of its course, he can, from the present learn the past, and descend into the future.

A certain number of phenomena belong to the same type, and are so intimately connected with each other, that we always find them in the same circumstances; there is a certain type of the anatomical state which always corresponds to a certain type of the symptomatic state, and then successive degradations of each which mutually correspond. A continuous chain connects these symptomatic degradations with each other; so that with the aid of the link which we have within our reach, it is possible, traversing in one or other direction the series of this group of phenomena, to ascend to the past or descend into the future. The group of alterations in *quality*, and that of the ronchi of phthisis are perfect illustrations.

The combinations of the phenomena with each other, are also regulated by fixed laws, on which depends what we call *the relative value of these phenomena.* In such or such circumstances, we find always, or almost always the same combination of signs. Such a phenomenon, coexisting with such another, has a certain value, which changes if it be alone, or if it be combined with any other; appearing in such circumstances, after such a phenomenon, it has quite a different value from that which it has when it appears in such other circumstances before the same phenomenon. When we know the general laws that govern the principal combinations of these signs with each other, if we meet a case where the more usual combinations are departed from, and an apparent confusion of symptoms renders the diagnosis obscure, we can very often, by ascending from the effect to the cause, and from the simple to the compound, discover the combination of different anatomical states that has occurred, from the combination of the different signs that we observe. In fact, just as certain organic states are more frequently combined among themselves than with others, so in like manner are the signs that correspond to them; but these signs, in combining, do not always preserve their primitive characters; they assume sometimes a different shade, under which it becomes more difficult to recognize them.

This analysis of the course of the phenomena, of their analogies, or their differences, of their various combinations, is more naturally placed after the study of each of them, than in a separate chapter. The general fact strikes us with more force, we perceive more clearly its origin and its applications, when it immediately follows the particular facts, than when it appears isolated and in an abstract form. Hence it is that I have endeavoured to point out successively the general facts, in proportion as the mind was prepared for them by the exposition of the particular ones. They will be found scattered here and there, especially in the second chapter: for example, at pages 9 and 10, 33 to 34, 41 to 46, 51 to 53, 66 and 67, 68 to 81, 103 to 104, &c. My object here, in recalling for a moment attention to this subject, is only to impress more deeply the importance of considering the symptoms in this point of view, and to insist a little upon some of the relations I have pointed out elsewhere.

1st. Instead of considering egophony, bronchophony, and pectoriloquy as three distinct phenomena, having no connexion with each other, shall we not derive some advantage in practice from bringing them under a common type, of which each is a different form or degree. In the first place it will, I believe, be more accurate to view them in this way, and then, aware of this fact, the ear will avoid the mistake it often makes, in always attributing to a difference in nature alterations in the phenomena, which most frequently correspond to different degrees only of the same anatomic state. Prepossessed with the idea that egophony appears only in pleuritic effusions, pectoriloquy in cavities, &c. we always infer their existence when we meet the symptom; we connect with one of these states, *distinct from every other*, an intermediate shade of the symptom, which in reality depends on an intermediate state; because we have accustomed ourselves to regard as always and altogether distinct from each other organic states, which are often combined and confounded together. Hence the errors I have pointed out.

In fact bronchophony, pectoriloquy, and egophony are very far from being separated from each other by such marked limits, such distinct characters as Laennec has asserted. It is at times impossible to tell with which of these phenomena we have to do; the most we can say is, that it is something which resembles one or the other. A continuous chain connects them together, composed of a number of links that seem to correspond to a similar number of intermediate degrees of pathological change. Do we not see Laennec himself recognize several degrees of his pectoriloquy, egophony, and bronchophony, and without suspecting it, establish a successive transition from one of these phenomena to another. "In conclusion," says he, "between perfect pectoriloquy and that which is quite doubtful, there are degrees with which practice makes us familiar, and which it would be as superfluous as it is difficult to describe." Dance, in like manner, says*, "that pectoriloquy is very often doubtful, and may easily be confounded with bronchophony, or vice versa, if we confine our attention to the modification or resonance of the voice alone." All who have devoted themselves peculiarly to the study of clinical medicine, know, that we often see bronchophony rise to the degree of pectoriloquy, when there is no trace of a cavity; and that on the other hand, in many cases of cavities, there is nothing more than simple bronchophonic reverberation of the voice. The distinction between bronchophony and pectoriloquy, is always a stumbling block to students; in general they will not admit that there is a difference in the nature of two phenomena which they see confounded with each other by insensible degrees. It is to the authority of Laennec, and not to the fact they submit. "Bronchophony, depending on pneumonic or tubercular induration, may be so *intense*, says M. Hirtz, that the lowest words of the patient are blown through the stethoscope to the ear of the observer; while daily observation proves that in cases of cavities, pectoriloquy is often very feeble and scarcely perceptible." Hence pectoriloquy is, in general, a sign of but little value in the diagnosis of the third stage of phthisis, while bronchophony, on the contrary, is of very great value in the diagnosis of tubercular or other indurations of the lungs. Pectoriloquy is really but a high degree of bronchophony; for we find that it is where the pulmonary induration is greatest, where the tissue is become most dense, that bronchophony attains the degree of pectoriloquy. The result is the same if we compare pectoriloquy and egophony. We see this in the following words of Laennec †: "Egophony is, of all the phenomena furnished by auscultation, that which seems to me most complex in its causes; it may readily be confounded with pectoriloquy, and still more easily with bronchophony, on account of the place in which it is usually heard. I myself confounded it for a long time with the first of these phenomena, and still longer with the second. My uncertainty as to the value of egophony was of longer duration, because it does not exist in every case of pleurisy, because bronchophony is still more frequently wanting in pneumonia, because these two diseases and consequently the two phenomena are often combined, and because the number of fatal cases of acute pleurisy is too inconsiderable to afford many opportunities of verifying, by examination after death, the exact relation between the phenomena observed and the interior lesions."

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* Dict. de Med. 2nd ed. t. 4, p. 413.

† Auscult. Med.; vol. 1, p. 87. Forbes's translation, p. 40.

We find between bronchophony and egophony the same gradual fusion as between bronchophony and pectoriloquy. It is, in many cases, as difficult to distinguish them from each other; we see them pass successively one into the other by shades that establish between them an absolute continuity. We often see the one occupy the place which Laennec assigned to the other: thus bronchophony alone is met in well marked cases of pleuritic effusion, and in the very conditions too, indicated by Laennec as favourable to the production of egophony; so also the egophonic character of voice is manifested in some cases where there is no alteration in the respiratory organs (see ch. 2, art. 7). "There is nothing, says Dance*, in the modification of voice produced by egophony, that essentially distinguishes it from bronchophony." M. Reynaud thinks, "that egophony is nothing but remote bronchophony, that is, heard through a layer of liquid†. Laennec, himself, admits that the combination of egophony and bronchophony may furnish three varieties, which he calls the trumpet-voice *(la voix de cornet)*, the counter voice *(la voix de jeton)*, and the punchinello voice *(la voix de polichinelle)*. It is very far from true, that these varieties only show themselves in the circumstances indicated by the discoverer of auscultation; we know, moreover, (see page 25) that the degree of pressure made by the ear on the chest, has a very great influence on the degree and form of vocal resonance we hear.

The conclusion from all this is, that egophony, bronchophony, and pectoriloquy, instead of being separated by distinct limits and characters, as is the case with phenomena differing in nature, are continued into each other by a chain of intermediate gradations; that they cannot be distinguished except at the extremities of this chain; that it is only in this last case, and under certain restrictions (see ch. 2, art. 7), that they correspond to the three anatomic types indicated by Laennec; while with respect to almost all their intermediate degrees, there is nothing very fixed in their relations with pathological anatomy; of the three phenomena bronchophony is that whose relations are most constant; a tolerably close connexion is found to exist between its degrees and the degrees of induration of the pulmonary tissue. (26)

2nd. Under the the name of alterations of *quality*, I have united in the same class a certain number of phenomena, hitherto regarded as quite distinct from each other, and have considered them as belonging to the same type, of which they are merely successive degradations (see p. 53). I have united in this class: 1°. metallic tinkling; 2°. the amphoric character; 3°. the cavernous character; 4°. the bronchial character; 5°. the blowing character; 6°. the resonant character; 7°. the clear character.

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* Dict. de Med. 2nd edit. t. 4, p. 415.

† Auscult. Med. edit. de M. Andral, note M. Laennec, p. 94.

It is in particular in the study of phthisis, that we can easily convince ourselves that all the alterations of metallic *quality* are identical in their nature, and only differ from the degree of anatomical change that produces them. 1°. when the pulmonary tissue becomes the seat of tubercular infiltration, sufficient to modify the *quality* of the sounds of respiration, we find the murmurs, the expiratory first, and afterwards the inspiratory, assume a clear, resonant, blowing *quality*, which we recognise as the pre-clude to the bronchial character; 2°. in fact, if we follow the progress of the affection, we soon see the bronchial character appear distinct, but feeble, and heard in expiration only; and now, in the corresponding points of the lung, the tissue is more indurated, the tubercular infiltration more advanced; 3°. the disease still increasing, the bronchial character next spreads to inspiration, and at the same time acquires more intensity in expiration; 4°. at length when the lung has acquired a great degree of density, the bronchial character appears in its most marked forms during both periods; 5°. while the pulmonary induration continues to increase round the tubercular masses, these soften at their centre, an excavation is hollowed out, the air of the neighbouring bronchus finds its way to it, and we see the bronchial character change by degrees into the cavernous; this increases in intensity as the cavity increases in size; 6°. if a vast cavity be formed in the lung, if moreover, it be separated from the ear by parts of no great thickness, and that it communicates with the bronchial system by a small opening, the cavernous respiration assumes the amphoric character; and this character becomes much more widely extended and much better marked, if instead of an excavation of moderate extent, such as phthisis produces in a lung, a communication be established by means of a pulmonary fistula, between the bronchial system and the corresponding pleural cavity. The same anatomical conditions exist in fact in the two last circumstances, only in a different degree in each. In both cases, there is a large excavation, partly filled with liquid, partly with air, and which receives, through a narrow opening, a column of air in respiration. (27)

In dilatation of the bronchi, there is nearly the same succession of phenomena, because there are nearly the same physical conditions: 1°. a cavity of increasing diameter; 2°. the pulmonary tissue that surrounds it undergoing successive degrees of induration. If the induration of the lung increases, or if the cavity in which the air moves enlarge, whether from mere dilatation of the bronchi, or from the formation of an excavation in the lung, or still more, if those two circumstances go on together, we see the blowing, bronchial, cavernous characters appear in succession, and the transition from one to the other is so gradual, that we are often embarrassed as to the precise determination of the character of two neighbouring phenomena. In a woman who died lately at No. 26, St. Martha's ward, under the care of M. Andral, the bronchi were found enormously dilated, on examination after death; some of them were nearly an inch in circumference at the surface of the lung, and in those points we had recognised during life most marked cavernous respiration; others exhibited a gradually decreasing developement, and as we had carefully noted the different points where such and such symptoms were heard, we were able to establish this relation between the symptoms and the pathologic alterations, that in proportion as we receded from the point of greatest dilatation, in passing to the normal state, we passed through the different varieties of metallic *quality* pointed out above.

3rd. We have seen that in the physiological state (see p. 33 and 34,) the *quality* of the respiratory sounds becomes more and more clear and metallic, in proportion as we ascend from the lower to the higher sections of the respiratory apparatus; we have seen that an intimate relation could be established between the successive elevation of the *quality* of these sounds, and the successively increasing physical conditions of the different sections of the respiratory apparatus; we have ascertained that in the pathological state the alterations of *quality* of the normal sounds compose a successive series, each degree of which is intimately connected with the new anatomical conditions in which the lung is placed. Now, the greatest analogy exists between the successive degrees of normal *quality*, and the successive degrees of morbid *quality*, because in reality nearly similar physical conditions belong to both. The similarity of effects depends on a similarity of causes. The successive increase of the diameter of the cavities traversed by the air in inspiration and expiration, and the successive increase of the conductibility and vibratory conditions of the walls of these cavities or of the surrounding tissues, are the two circumstances on which the successive alterations of *quality* in the respiratory sounds depend, and these circumstances exist in both cases. We might, even *a priori*, pass from physiology to pathology, and say, if anatomical alterations take place in the lung of such a kind, that they represent more or less closely the normal conditions of the respiratory canals, alterations of *quality* nearly similar to the successive degrees of the normal sounds must be produced; now this reasoning is perfectly applicable, as is seen, to the anatomical and symptomatic conditions of phthisis and of dilatation of the bronchi. Thus it is that physiology and pathology are twined together, and afford to each other the support of analogy, if we will only take the trouble to ascertain the relations of the facts, and to ascend constantly from the phenomena and their varieties to the physical causes that determine them.

CHAPTER IV.

CLASSIFICATION OF THE PHYSIOLOGICAL AND MORBID SONOROUS PHENOMENA OF RESPIRATION.

The two following tables exhibit in a summary form the arrangement I adopted in my researches on the physiological and morbid characters of the respiratory sounds.

In the first are seen, in the first place, the *primary characters* of the respiratory sounds which have served as the basis of my observations, in the physiological and in the morbid state.

A brief exposition of the nature of these primary characters in the normal respiratory murmurs, in the voice and in the cough, occupies the remainder of this first table, and establishes the limits between the physiological and morbid states of these sounds, without a knowledge of which the observer, embarrassed in his judgment, can derive no profit from auscultation.

In the second table are comprised all the forms of the respiratory sounds, of the voice and of the cough, that exceed these limits, that is, that constitute the morbid state, and which are discovered by analyzing the primary characters placed at the top of the first table.

TABLE OF THE PHYSIOLOGICAL SOUNDS OF RESPIRATION.

Primary characters to be studied in the physiological and morbid sounds of respiration.

1⁰. Proper or distinctive character;
2⁰. Hard or soft character;
3⁰. Dry or humid character;
4⁰. *Quality;*
5⁰. Tone;
6⁰. Intensity;
7⁰. Duration;
8⁰. Rhythm.

A. Inspiratory and expiratory murmurs:

Vesicular Section.	A pure light breathing. Soft, free, mellowy character. Neither dry nor humid but between both. Intensity of inspiration represented by 10. Intensity of expiration represented by 2. Duration of inspiration represented by 10. Duration of expiration represented by 2. Murmurs successive in their duration but not conveying the impression of the developement of cells. Murmurs more marked in front than behind. Murmurs somewhat more marked superiorly than inferiorly. Murmurs the same at each side of chest.
Bronchial, tracheal, laryngeal, pharyngeal, buccal, and nasal Sections.	Bronchial and tracheal murmurs not heard, in the normal state, through the pulmonary tissue. Tracheal, laryngeal, pharyngeal, buccal, and nasal murmurs, heard in the normal state, as well at a distance as by mediate or immediate auscultation; better heard in proportion as they belong to a higher section of the respiratory apparatus. Murmurs tending more and more to become equal in intensity and duration, in proportion as they belong to a higher section of the respiratory apparatus. Murmurs whose *quality* is more and more marked, in proportion as they belong to a higher section of the respiratory apparatus.

B. Sounds of the voice and cough heard by mediate or immediate auscultation:

1⁰. *Voice.*	2⁰. *Cough.*
Sound tolerably distinct.	Sound dull.
—— rather obscure.	—— somewhat elevated.
—— a kind of buzzing.	—— short.
—— somewhat jerking.	—— somewhat stifled.
—— diffused beneath the ear.	—— diffused beneath the ear.
Words of the patient indistinct.	

TABLE OF THE MORBID SOUNDS OF THE RESPIRATORY APPARATUS FURNISHED BY AUSCULTATION.

A. Morbid sounds of inspiration and expiration:

1st Class. Simple modifications of the intensity and duration of the normal murmurs.	Augmentation of the intensity and the duration.		of the inspiratory murmur—from 10 to 20.		
			of the expiratory murmur—from 2 to 20.		
	Diminution of the intensity and the duration.		of the inspiratory murmur—from 10 to 0.		
			of the expiratory murmur—from 2 to 0.		
	Cessation of the intensity and the duration.		of the inspiratory murmur of the expiratory murmur	represented by 0.	
2nd Class. Changes in the nature of the normal murmurs.	Perversion.	1°. Of the *quality*........	Clear character.		
			Resonant character.		
			Blowing character.		
			Bronchial character.		
			Cavernous character and veiled puff.		
			Amphoric character.		
			Metallic tinkling and metallic resonance.		
		2°. Of the tone	Grave tone.		
			Acute tone.		
		3°. Of the rhythm.......	Disturbance of the rhythm of one or other of the respiratory murmurs.		
			Disturbance of the normal ratio between the inspiratory and expiratory murmurs.		
		4°. Of the soft, free, mellowy character.	Character of hardness, roughness, restraint.		
		5°. Of the character between dry and humid.	Dry character	Pleuritic friction sound.	
				Pulmonary crumpling sound.	
				Crackling ronchus.	
				Dry ronchi.	
			Humid Character.	Humid character of respiration.	Simple humid.
					Viscid humid.
					Bubbling humid.
				Humid ronchi.	

B. Morbid sounds of the Voice and of the Cough, heard by mediate or immediate auscultation:

1°, *Voice:*	2°. *Cough:*
Ægophony.	Bronchial cough.
Bronchophony,	Cavernous cough.
Pectoriloquy.	

Classification of the ronchi in particular.

A good classification of the ronchi is of more importance than perhaps some may suppose, for the diagnosis and prognosis of the affections to which they belong. These phenomena are very numerous, very important in semeiology; hence it is most necessary to establish such well defined limits between their characters, as will enable us to recognize them wherever they appear, to distinguish them from each other, and to refer them to the anatomical conditions which they represent.

M. Andral's classification of the ronchi, founded on their place of origin, in such or such a section of the respiratory apparatus, is most generally adopted; it is the one that, in the actual state of science, is best suited to the wants of the subject. That which I propose is in part borrowed, as will be seen, from M. Andral's; but, instead of taking a single character as the basis of classification, as has been hitherto generally done, it appeared to me more advantageous to take several; some principal, some accessory. The characters I have taken are the following; 1°. their seat or place of origin; 2°. their bubbling or non-bubbling character; 3°. their dry or humid character. These are, it is plain, the characters that are most common, most constant, and most easily analyzed; they are also those which establish the most direct relation between the phenomenon and the circumstances that produce it.

1°. *Seat.*

The position assigned to the ronchi in such or such a part of the respiratory apparatus is often in a great degree conjectural; but, apart from this inconvenience, which after all only applies to a small number of cases, and is corrected by combining together several bases of classification, the consideration of the seat of the ronchi is very important; it assists in localizing in this or that portion of the same system the affection on which the ronchus depends; it harmonizes also perfectly, in the great majority of cases, with the peculiar form of the ronchus, with its constant and inconstant character, &c.; frequently it affords a key to the mechanism of its production. Ronchi may be produced in any part of the passages traversed by atmospheric air, from the mouth to the air cells; but in general we comprehend under this name only the sounds produced in the laryngo-bronchial canals.

2°. *Bubbling or non-bubbling character.*

This character is essentially clinical. It divides the ronchi into two very distinct classes: one class gives to the ear the sensation of bubbles that arise, are developed, and burst in the midst of a matter more or less liquid, more or less viscid; in the other we at once distinguish that there are no bubbles, that it is a kind of continous sound, like blowing, whistling, or a note struck on a base cord. These two sensations are perfectly distinct; persons the most inexperienced in auscultation at once rank a ronchus in one or other of these classes. These two physical characters are the most constant as to the laws that regulate them, the most marked in their form, and the most easily recognized and analyzed.

3°. Whether a ronchus be of the bubbling or non-bubbling class, it always gives the sensation of dryness or humidity. This sensation is very distinct in well marked cases; it is by no means so in the points of contact of the dry and humid ronchi, and these points of contact are rather numerous; besides, a ronchus which is dry to day may be humid to-morrow. This character, therefore, though furnishing a very good means of distinguishing the ronchi, may not be sufficient for this purpose, as there is a point where it ceases to be applicable. The bubbling or non-bubbling character, on the other hand, if employed alone, would sometimes prepossess the mind rather too much as to the mechanism of formation of the ronchi; besides, the same sonorous phenomenon, in passing through its different phases, may at first not belong to the bubbling class, and afterwards come to take its place there. Such are the ronchi we have described under the name of dry crackling and humid crackling.

It is evident that no one of these three principal characters will in itself suffice for a complete and accurate classification of the ronchi. The three together, on the contrary, comprehend every thing important to be known in a ronchus, as well for the purpose of distinguishing it from others, as of referring it to the causes that produce it, and hence of making use of it as a means of diagnosis and prognosis. Ranged after each other, according to their degree of importance, they mutually correct whatever deficiency or excess there may be in each. This compound basis of classification has also another advantage; that of contrasting those three principal characters with each other, of uniting them by their natural relations, by certain general views which result from contemplating them all together. This mode of classification, more perhaps than any other, puts us in the way of discovering the relation of a phenomenon with its causes, as well physical as physiological. Thus it is that the formation of bubbles, supposing the concurrence of two conditions, of a column of air and some kind of liquid meeting in a cavity, we might *a priori* conclude that all the bubbling ronchi would be humid, and that all the non-bubbling ronchi would be dry, because it is from the absence of one of the preceding conditions that the latter ronchi originate; now, this is exactly the result obtained by observation. Thus it is that, inasmuch as the bubbles of a ronchus cannot exceed in magnitude the cavity in which they are generated, we have reason to think, and observation confirms the opinion, that we may judge of the part of the trachea-bronchial apparatus in which the ronchus is produced, by the size of the bubbles: in fact all the vesicular ronchi have small bubbles; all the humid bronchial ronchi have voluminous bubbles, and so likewise the gurgling ronchus. Thus it is that, liquids having a tendency to settle in the vesicular section of the lung, which is the most depending part, and the more or less round form of the air cells being besides a physical condition favourable to the production, to the formation of bubbles, we might at once conclude that the ronchi produced in the vesicular section must be both bubbling and humid; now, this *a priori* result is confirmed by observation. We might farther conclude that every disease that tends to obstruct the pulmonary cells, and to produce in them a more viscid humidity than usual, ought to render the bubbles, if they form at all, smaller and more dry; for example, the primary crepitant ronchus of pneumonia compared with the subcrepitant ronchus of œdema.

This classification, founded on a compound basis, has these indisputable advantages over classifications founded on an exclusive character; it does not, however, correspond to all the wants of the subject, it does not satisfy the mind on all points. This fault is less in the classification than in the imperfect knowledge we still possess of several of the phenomena it comprehends.

The seat is the character taken as the first basis of classification; the bubbling or non-bubbling character comes next; the dry and humid character last.

Considered in respect to their seat, the ronchi may be divided into six classes.

1°. Intra-vesicular; 2°. extra-vesicular; 3°. bronchial; 4°. tracheal; 5°. laryngeal; 6°. bucco-pharyngeal.

1°. *Intra-vesicular ronchi.*

These are supposed to be produced within the air cells. They are all bubbling, all have the humid character; they are the following: as they have different degrees of humidity, I arrange them here in the order of their decreasing humidity:—

1°. Humid ronchus with continuous bubbles of sanguineous congestion; 2°. subcrepitant ronchus of œdema; 3°. subcrepitant ronchus of acute capillary bronchitis; 4°. subcrepitant or crepitant ronchus redux of pneumonia; 5°. primary crepitant ronchus of pneumonia.

2°. *Extra-vesicular ronchi.*

They naturally form two secondary classes, according as the tissue of the lung has preserved its continuity, or as it has been excavated.

1st. In the first case we find two peculiar sounds to which I have already devoted a special description; these are the crackling, and pulmonary crumpling sounds, or ronchi. I conceive that these peculiar sounds are formed outside the air cells, by the compression of the pulmonary tissue against the foreign bodies (the tubercles) that are deposited in it. This opinion is not, as may be supposed, a mere conjecture. It is the result of the comparisons I have made between the pathological changes and the symptoms in the cases I observed. It is the result of some experiments on sponge artificially approximated to the different morbid conditions of the pulmonary tissue; experiments of which I have given an idea in another part of this work (see p. 16).

The crackling and crumpling ronchi are each dry and non-bubbling. The crumpling ronchus preserves this character during its entire duration; it never exists except in this form. The crackling ronchus, on the contrary, has two periods, one in which it is dry and non-bubbling, the other in which it is humid and bubbling; the transition from the one to the other is quite gradual.

2nd. The preceding ronchi prepare the way for the second order of extra-vesicular ronchi; for the latter, which we are now about to notice, are nothing but the gradual degradation of the crackling ronchi. The dry crackling commences the chain, the humid crackling forms the second link; after this there is a solution of continuity, and later still an excavation of the pulmonary tissue, and we find the mucous ronchus with a clear or cavernulous *quality*, the dry cavernous ronchus, and the gurgling successively appear. These ronchi, in fact, constitute this second order. They are all bubbling, all humid, with the exception of the dry cavernous ronchus. This last has not been described; it is produced in circumstances that are not common where cavities, completely drained of liquids, and somewhat dried up in the interior, are in the same condition with respect to the atmospheric air, as the bronchi and trachea in the first stage of acute bronchitis. So, too, the effects, the sounds produced, are nearly the same; they differ only in their *quality*, cavernous in the one case, bronchial in the other, that is, in the form and diameter of the cavities in which they are generated. The tone of the dry cavernous ronchus, like that of the dry bronchial, may be grave or acute.

3°. *Bronchial ronchi.*

Those that are produced in the bronchial system. Here we encounter the inconvenience of a classification founded on the seat. For we cannot determine an exact limit between the bronchial and vesicular sections; consequently the two classes of ronchi must be more or less confounded at their point of contact. The conditions of dryness and humidity being very easily produced here, and being, in fact, often produced in different morbid circumstances, we have the four secondary classes of bubbling and non-bubbling, dry and humid ronchi.

The following are the bubbling and humid bronchial ronchi; I arrange them in the order of their maximum of humidity.

1°. The gurgling (*gargouillement*) in cases of considerable dilatation of the bronchi; 2°. the mucous with large bubbles; 3°. the mucous with moderate bubbles; 4°. the mucous with small bubbles.

The non-bubbling and dry ronchi are, some grave, as the sonorous and snoring ronchi; some acute, as the sibilant and whistling. Some varieties are derived from each of these orders.

4°. *Tracheal ronchi.*

The physical conditions of the trachea are nearly the same as those of the bronchi; accordingly we find in both precisely the same ronchi; the only difference is that in the tracheal, the dry have a greater intensity, and the humid larger bubbles.

The bubbling tracheal ronchi are reduced to one alone, the ronchus of the dying.

The non-bubbling and dry ronchi, like the preceding, are some grave, as the tracheal ronchus; some acute, as the tracheal whistling.

5°. *Laryngeal ronchi.*

No bubbling ronchus is generated in this section of the respiratory apparatus. The non-bubbling ronchi are dry, some grave, some acute.

6°. *Bucco-pharyngeal ronchi.*

(See what I have said of them at page 123.)

With respect to the ronchus which Laennec considered pathognomonic of interlobular emphysema of the lungs, and which he called dry crepitant with large bubbles, every thing leads me to think, as I have said at page 122, that it is nothing but the crepitant ronchus of acute capillary bronchitis.

TABULAR CLASSIFICATION OF THE RONCHI.

I. Intra-vesicular ronchi		Bubbling—Humid	1°. Humid ronchus with continuous bubbles of active sanguineous congestion of the lungs.	
			2°. Sub-crepitant ronchus of pulmonary œdema.	
			3°. Sub-crepitant ronchus of acute capillary bronchitis.	
			4°. Crepitant or sub-crepitant ronchus redux of pneumonia.	
			5°. Primary crepitant ronchus of pneumonia.	
		Non-bubbling		
II. Extra-vesicular ronchi.	1st. Without excavation of the tissue of the lung.	Bubbling.—Humid	Humid crackling ronchus.	
		Non-bubbling.—Dry	1°. Dry crackling ronchus of phthisis.	
			2°. Crumpling ronchus of phthisis, &c.	
	2nd. With excavation of the tissue of the lung.	Bubbling—Humid	1°. Mucous ronchus with clear or cavernulous *quality*.	
			2°. Gurgling ronchus.	
		Non-bubbling—Dry	Dry cavernous ronchus	Grave toned. Acute toned.
III. Bronchial ronchi		Bubbling—Humid	1°. Gurgling ronchus in considerable dilatation of the bronchi.	
			2°. Mucous ronchus with large bubbles.	
			3°. Mucous ronchus with middling bubbles.	
			4°. Mucous ronchus with small bubbles.	
		Non-bubbling—Dry	Grave toned.	Sonorous ronchus. Snoring ronchus. Wood-pigeon sound. Base-string sound, &c.
			Acute toned.	Sibilant ronchus. Hissing ronchus. Bird's cry, &c.
IV. Tracheal ronchi		Bubbling—Humid	Tracheal ronchus of the dying.	
		Non-bubbling—Dry	Acute toned.—Tracheal hissing. Grave toned.—Tracheal ronchus.	
V. Laryngeal ronchi		Bubbling		
		Non-bubbling—Dry	Grave toned.—Laryngeal ronchus. Acute toned.—Laryngeal hissing.	
VI. Bucco-pharyngeal ronchi		Bubbling—Humid	Bucco-pharyngeal ronchus, with fine delicate bubbles.	
		Non-bubbling		

BUBBLING RONCHI—HUMID.

1. Humid ronchus with continuous bubbles.
2. Sub-crepitant ronchus of œdema.
3. Sub-crepitant ronchus of acute bronchitis.
4. Crepitant ronchus redux.
5. Primary crepitant ronchus.
6. Humid crackling ronchus.
7. Mucous ronchus with small bubbles.
8. Mucous ronchus with middling bubbles.
9. Mucous ronchus with large bubbles.
10. Cavernulous ronchus or mucous with clear *quality*.
11. Gurgling ronchus.
12. Tracheal ronchus of the dying—*dead-rattles*.
13. Bucco-pharyngeal ronchus with fine, delicate bubbles.

NON-BUBBLING RONCHI—DRY.

1°. GRAVE TONED.

1. Dry crackling ronchus of phthisis.
2. Pulmonary crumpling sound or ronchus.
3. Dry, snoring, cavernous ronchus.
4. Bronchial sonorous ronchus.
5. Bronchial snoring ronchus.
6. Bronchial wood-pigeon ronchus.
7. Bronchial base string ronchus.
8. Tracheal ronchus.
9. Laryngeal ronchus.

2°. ACUTE TONED.

10. Bronchial sibilant ronchus.
11. Bronchial hissing ronchus.
12. Bronchial bird's-cry ronchus, &c.
13. Tracheal hissing.
14. Laryngeal hissing.

CHAPTER V.

LAWS OF COEXISTENCE OF THE MORBID SONOROUS PHENOMENA OF THE RESPIRATORY SYSTEM WITH INSPIRATION OR EXPIRATION.

The separate study of the two periods of respiration, necessarily leads to the investigation and determination of the laws of coexistence of each of the sonorous phenomena of the respiratory apparatus, with one or other of the two respiratory murmurs. We find in these laws of coexistence of the morbid sounds with inspiration or expiration, a number of differential characters which are useful in practice. Certain sounds, of very different diagnostic value, are sometimes confounded with one another in many respects, and distinguished by this character: that some coexist with both periods of respiration, while others coexist with one only; such are, for example, the humid bronchial ronchi, compared with the vesicular ronchi. There are other signs, which appearing first in expiration, and not extending till later to inspiration, enable us in this way to estimate the progress of the disease; such are the alterations of *quality*. The constancy, for the most part, of the laws of coexistence of the sonorous morbid phenomena with this or that period of respiration, gives, in general, considerable value to the signs derived from this source. Nor indeed is this means of diagnosis altogether unknown; the idea of employing it occurred to several; we find traces of it here and there in their works; but almost all have confined it to the study of the ronchi. M. Andral* has sanctioned the principle. Laennec had applied it to the dry crepitant ronchus, which he considered pathognomonic of interlobular emphysema†. Dance had done the same for the crepitant ronchus of pneumonia‡. M. Hirtz, in the excellent thesis he has published on auscultation, seems to have paid scarcely any attention to this subject‖. The authors of the Compendium de Medecine Pratique have given it more consideration, and have summed up all that had been previously said respecting it§.

1st. Each of the two classes of morbid sonorous phenomena that we have described may be met alike in inspiration and in expiration. The morbid sounds of the second class, however, seem to belong more peculiarly to expiration, in this sense, that the greater number of them appear first in it, and, moreover, always maintain there their maximum of developement.

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* Auscult. Med. ed. d'Andral, vol. 1, p. 136.

† Ibid.

‡ Dictionaire de Medecine, 2nd edit. t. 4, p. 400.

‖ These Inaugurale, p. 26.

§ Tome 1, pages 472, 482, 483.

2nd. The modifications by augmentation are met almost equally in expiration and inspiration; but those that coexist with expiration are of far greater importance in diagnosis than the others. The modifications by diminution belong much more peculiarly to inspiration than expiration, and are besides much more frequent in it. The complete cessation of expiration is very rare compared with that of inspiration.

3rd. All the morbid sonorous phenomena comprehended in the first group of the second class (alterations of *quality*) are much more intimately connected with expiration than inspiration. They have all a common character, that of appearing always in succession, never at the same time, in the two periods of respiration. They appear first in expiration, afterwards extend to inspiration, preserve for a long time a higher degree in the former, and never present the same degree of intensity in both, except towards the end of their course, when they have attained their maximum of developement.

4th. No very fixed law governs the coexistence of the grave or acute tone with inspiration or expiration. We meet them sometimes in one, sometimes in the other of these periods; however, we find the grave tone coincide more frequently with the second, and the acute tone with the first.

5th. It is usually through the expiration that the ratio between the inspiratory and expiratory murmurs is disturbed; but in general this disturbance depends on modifications produced in both sounds at the same time; especially when these modifications are of opposite kinds.

6th. The characters of hardness, roughness, difficulty, shew themselves in general in inspiration before they appear in expiration; they remain always more sensible in the former. They never become well marked in the expiratory murmur, until its intensity and duration are greatly augmented, and that some trace of change of *quality* has appeared in it, as in emphysema of the lungs.

7th. It is the same with respect to the characters of dryness and humidity; they coexist in particular with inspiration, but they may also be met in expiration, under the same conditions as the preceding characters.

8th. With regard to the ronchi, we may say, in general, that they belong more peculiarly to inspiration. This is what we would expect, as the column of air is better able to act on the liquid in the respiratory canals in a way calculated to produce these sounds, in inspiration than in expiration.

We see, on the whole, that the division is somewhat unequal between inspiration and expiration: the greater part belongs to the former. But if it be true, that the greater number of the morbid sonorous phenomena *ng more* peculiarly to inspiration, it is not less so, that these that are most important are found much more immediately connected with expiration; the one has the advantage in number, the other in value.

1st. In supplementary respiration, the slight clear *quality* which is present occupies equally both periods; whilst in morbid respiration, if there be a commencement of alteration of *quality*, it exists only in expiration; or if it coexists with both periods, it is more marked in it.

2nd. In normal bronchial respiration, such as is heard over a small space at the root of the lungs, the bronchial *quality*, from its low degree, is audible in expiration only; so true is this, that we may establish as a general rule, that wherever the bronchial character, coexisting in a well marked manner with both expiration and inspiration, is audible at the root of the lungs, there is every reason to think it is the morbid and not the normal bronchial character we hear.

3rd. The law that determines the coexistence of the alterations of *quality* with expiration first, and then with inspiration, during their period of increase, remains the same during their decrease; that is to say, that the same series of phenomena takes place in an opposite direction, and that it is in the expiration the alterations of *quality* are last heard. By means of this law we can estimate the decreasing as we did the increasing course of the disease.

4th. The more elevated the form in which the alterations of *quality* exist, the more equally do they affect inspiration and expiration, still, however, in general preserving a little more developement in expiration.

5th. In some cases of hydropneumothorax with perforation, the metallic tinkling described by Laennec is entirely wanting; but, in its stead, the amphoric character of the respiration seems to reverberate in a vague diffused sound, a sort of echo which resounds in the chest, and rings like the voice under an arch; this phenomena may be designated *metallic resonance*. It often accompanies both the voice and cough, and is sometimes produced along with metallic tinkling. It coexists with both periods indifferently.

6th. With respect to metallic tinkling, it belongs peculiarly, but not exclusively, to expiration. We know, in fact, that the way to produce it is to make the patient cough, or speak, or expire forcibly while we are auscultating the chest: now, coughing and speaking are but modes of expiration. If it is produced during both periods, it is most marked in expiration.

7th. The pleuritic friction sound in its 1st degree, the grazing sound, is heard only in inspiration. In its 2nd degree it may be audible during both inspiration and expiration, but it is more marked in the former. In the 3rd degree it coexists with both. It may be equally intense in both, but in general it is more marked in inspiration. In conclusion, the pleuritic friction sounds are found less frequently coinciding with expiration, in proportion as they are weaker, and as they are more near their origin or cessation. During the decrease of a pleuritic friction sound, chiefly in inspiration; whilst in the bronchitis of the large tubes that accompanies emphysema, it rather coexists with expiration, and is then more marked.

2°. *Humid bronchial ronchi.*

They are distinguished by the general name of mucous. The mucous ronchi with small bubbles may appear, and usually do appear at the same time in both expiration and inspiration; there is even in this a good differential character between these ronchi and all those included under the name intravesicular ronchi. Their coexistence with the two periods of respiration is more equal and more constant, in proportion as they become more humid and more voluminous.

IV. and V. *Tracheal and laryngeal ronchi.*

The tracheal and laryngeal ronchi follow exactly the same law as the bronchial.

VI. *Bucco-pharyngeal ronchi.*

The small bucco-pharyngeal ronchus, with fine, delicate, slight bubbles, which I have already described, is heard chiefly in inspiration, but is also perceptible in expiration.

Such are the laws that regulate the coexistence of the different ronchi with this or that period of respiration. They may be reduced to a certain number of general principles as follows:

1st. The more nearly the seat of any ronchus, whether it be dry or humid, bubbling or non-bubbling, approaches the vesicular extremity of the respiratory apparatus, the more exclusively does it belong to inspiration. For example, the entire class of intra-vesicular, and the first order of the class of extra-vesicular ronchi.

2nd. On the other hand, the more the seat of a ronchus approaches the exterior extremity of the respiratory apparatus, the more equal and constant is its coexistence with both inspiration and expiration at the same time.

3rd. The interval between these two extremes is occupied by a number of intermediate degrees, in which are arranged, always according to the same principle, the ronchi which ascend by successive steps from an exclusive coexistence with inspiration, to a common coexistence with both periods of respiration.

4th. The general principle contained in the three foregoing propositions appears under a different form in the following: the exclusive coexistence of the ronchi with inspiration alone is more marked in proportion as they originate in a narrower part of the respiratory system, for example, in the vesicular section. On the other hand, they extend to expiration, and coincide more and more with both periods, in proportion as they are seated in a wider part of it (for example, the mucous and the dry bronchial ronchi, compared with the extra-vesicular ronchi

TABLE SHOWING THE LAW OF COEX PIRATION.

The order in which the phenomena ar them.

1°. **Morbid Characters coexisting exclusively, or almost exclusively with inspiration.**

1. Humid ronchus with continuous bubbles.
2. Primary crepitant ronchus of pneumonia.
3. Mucous ronchus of the 3rd stage of pneumonia.*
4. Grazing pleuritic friction sound.
5. Pulmonary crumpling sound.
6. Dry crackling ronchus.
7. Sub-crepitant ronchus of œdema.
8. Sub-crepitant ronchus of capillary bronchitis.
9. Crepitant ronchus redux of pneumonia.

The three first sounds coexist exclusively with inspiration; the others sometimes occur in expiration also, but only as exceptions. The frequency of these exceptions increases from No. 4 downwards.

2°. **Morbid charact**
isting at once w
inspiration and e

1. Humid cavern
chus.
2. Dry cavernous
3. Dry { bronchial
tracheal
4. Cavernulous ro
5. Rasping pleuri
tion sound.
6. Proper pleuriti
sound.
7. Augmentations
sity.
8. Diminutions of i
9. Augmentations
tion.
10. Diminutions of
11. Amphoric char
12. { Cavernous c
Veiled puff.
13. Bronchial char
14. { *Metallic* tink
——— res
15. Blowing chara
16. Resonant chara
17. Clear character
18. Mucous ronchi.
19. Humid crackli
chus.
20. Dry, hard, ro
racter.
21. Humid characte

aracters coex-
ly with inspi-

on of intensity
ion.
cessation.
aracter.
acter.
friction sounds.
y crumpling
kling ronchus.
itant ronchus of
itant ronchus of
bronchitis.
t ronchus redux
onia.
crackling ron-
aryngeal ron-
lous ronchus.
ronchus.
hial } Humid ronchi.
eal
geal
hial } ronchi, dry and acute toned.
nous
eal
geal

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* See what was said of this ronchus at page 122.

of the 1st order); in like manner, when they are produced in newly formed cavities, they coexist more equally with both inspiration and expiration, in proportion as the diameter of the cavity is larger; for example, the successive series of the humid crackling, cavernous, dry cavernous, and gurgling ronchi.

5th. The bubbling ronchi are found to coexist more with both periods in proportion as their bubbles are voluminous. On the contrary, they coexist more exclusively with inspiration, in proportion as their bubbles are smaller. The same law is applicable to the degree of humidity of the fine bubbling ronchi; thus we have seen that the coexistence of the vesicular ronchi with inspiration is in general more exclusive according as they have less of the humid character.

6th. The more intense the dry non-bubbling ronchi are, the more they invade both inspiration and expiration at once; and *vice versa*, the more feeble they are, the more exclusively do they coexist with inspiration; for example, the dry bronchial ronchi compared with the dry ronchi of the 1st order of the extra-vesicular class.

7th. The coexistence of the dry, non-bubbling ronchi, with this or that period of respiration, corresponds in a similar manner with their tone. Thus the ronchi whose tone is grave coexist more peculiarly with expiration, and those whose tone is acute with inspiration.

8th. The ronchi that coexist exclusively with inspiration depend in general on more serious affections than those that coexist with both inspiration and expiration at the same time.

This principle would be completely general, but for the humid crackling and the gurgling ronchi, which are exceptions to it.

I have placed here a tabular view of the coexistence of the morbid sounds of the respiratory system with this or that period of respiration.

I have divided this table into six columns. The first includes all the sounds that coexist exclusively or almost exclusively with inspiration. In the second are those that coexist at the same time with the two periods of respiration. I have placed in the third those sounds which are first heard in inspiration and afterwards extend to expiration. In the fourth those that commence in expiration and spread afterwards to inspiration. The fifth includes those that coexist with both periods, but are more marked in expiration. Lastly, I have united in the sixth those that coincide with both, but are more marked in inspiration. No morbid character coexists exclusively with expiration.

With this table, and those formerly given, in addition to the general principles already laid down, it is easy to establish useful diagnostic relations between the different sonorous morbid phenomena of the respiratory system, considered under the point of view of their coexistence with one or other period of respiration.

I may mention here some of the results of differential diagnosis that may be thus obtained.

1st. When the metallic *quality* of the respiratory murmurs appears in both periods, and *at a very low degree,* this is sufficient to warrant the opinion that it is the clear metallic quality peculiar to supplementary respiration, and not that which respiration presents in the first stage of phthisis; this is, in general, sufficient to warrant us in ascribing the modifications of intensity and duration presented by the respiratory murmurs to the first, and not to the second of these causes.

2nd. If the bronchial character, after having existed exclusively in expiration, makes its appearance, after a longer or shorter period, in inspiration, we can have no doubt that the disease to which it corresponds has increased, and we can measure with tolerable exactness the progress it makes by the degree of intensity successively acquired by the bronchial character.

3rd. If we have satisfied ourselves that the bronchial character exists only in expiration, we may be sure it does not belong to supplementary respiration.

4th. If this bronchial character be heard in the region corresponding to the root of the lungs, and if at the same time it presents that degree of intensity I have elsewhere described as the third degree, we may be very certain it is not the natural bronchial character.

5th. If, while the inspiratory murmur is audible to a certain extent, we can perceive no trace of the expiratory, we will have reason to think that this separate cessation of the expiratory murmur is merely the momentary effect of the manner in which the patient respires, and is not connected with any morbid state of the chest. If the patient be led to breathe more naturally, the murmur of expiration will at once appear. In fact the separate cessation of the expiratory murmur does not correspond to any morbid state.

6th. We may come to the same conclusion, if, while the expiratory murmur maintains perfectly its duration, its intensity, and its normal *quality*, the inspiratory is inaudible.

7th. Among the bubbling ronchi, there are some that might be confounded with each other, and that may be distinguished by their coexistence with inspiration or expiration. Thus, the primary crepitant ronchus of pneumonia is distinguished from the crepitant ronchus redux, by the fact that in the latter some bubbles are heard during expiration, while the bubbles of the former are only heard in inspiration. In the same way we may distinguish the primary crepitant ronchus and the humid ronchus with continuous bubbles from the subcrepitant of œdema, the subcrepitant of acute capillary bronchitis, &c. which, though coexisting chiefly with inspiration, produce usually a few bubbles in expiration. We may with still more certainty distinguish them, by this means, from the humid crackling ronchus, and especially from the bronchial mucous ronchus with small bubbles, the essential character of which is their *coexistence* at once with both periods of respiration.

8th. If, in the course of a pneumonia, a mucous ronchus appear, constantly and exclusively coexisting with inspiration; if, moreover, the general symptoms are increasing, or at least stationary, we will have some reason to think that the hepatization has passed to the state of purulent infiltration.

9th. If a sound more or less like the dry crackling ronchus, or the pulmonary crumpling, appeared in the summits of the lungs, and if, instead of coexisting exclusively, or almost exclusively, with inspiration, it coexisted with nearly as much constancy and uniformity with both, this would be a strong reason for thinking that it was not the real crackling or crumpling sound.

10th. The facts of coexistence I have detailed are, in my opinion, so constant, for all the more important morbid respiratory characters, that I do not hesitate to lay down as a principle: that their diagnostic and prognostic value are directly proportional, 1°. to the degree of exactness with which they conform to the preceding laws; 2°. to the constancy with which they do so. (28)

CHAPTER VI.

CHARACTERS PRESENTED BY THE INSPIRATORY AND EXPIRATORY MURMURS IN EACH OF THE DISEASES OF THE RESPIRATORY SYSTEM CONSIDERED SEPARATELY.

The method I have adopted in the study of auscultation, authorizes numerous changes in the symptomatology of the diseases of the respiratory organs laid down by Laennec. This obliges me to present a brief outline of this symptomatology, as it is supplied by the method of auscultation that has guided me in my researches. I do not intend to notice all the diseases of the respiratory system; this would carry me much too far. I will only examine those that are most common, and are of considerable importance in practice. After the descriptive details into which I have already entered, and the general principles I have laid down, it will be easy for any one to extend this symptomatic exposition to the diseases I leave unnoticed.* Sometimes I will join with the auscultatory signs, some other signs that result from my researches on percussion, palpation, and inspection.

This rapid survey of the symptomatology of the affections of the respiratory system, will afford me an opportunity of stating some diagnostic and pathological facts, which have not found a place in the preceding chapters.

ARTICLE I.

DISEASES OF THE BRONCHI.

§ I. Acute bronchitis of the large bronchial tubes.

1st *stage.*—1°. Increase of the intensity and duration of the inspiratory and expiratory murmurs, easily recognized wherever the sonorous and sibilant ronchi are not heard. The increase is greater in the expiratory than in the inspiratory murmur, reminding one of the characters of supplementary respiration.

2°. A little dryness and hardness of both murmurs, wherever the sonorous and sibilant ronchi are not heard.

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* I mean to describe merely the general morbid characters presented by the inspiratory and expiratory murmurs, in the diseases of the respiratory system; and not by any means to enter into a detail of all the varieties these murmurs may exhibit in the different diagnostic circumstances that may arise.

3°. Dry bronchial ronchi, both acute and grave, but especially the latter, and heard chiefly in expiration. These ronchi present a very high degree of intensity.

2nd *stage*.—1°. Exaggeration of the respiratory murmurs not carried quite so far.

2°. The humid and viscid character taking the place of the dry one.

3°. Humid bronchial ronchi, the bubbles growing larger and larger, more and more humid.

§ II. ACUTE CAPILLARY BRONCHITIS.

1st *stage*.—1°. Slight diminution of the duration and intensity of the two respiratory murmurs, but especially of the inspiratory, at the postero-inferior part of both sides of the chest. In proportion as we recede from this point posteriorly, the diminution of the inspiratory murmur becomes less and less sensible, and the expiratory becomes a little exaggerated. In front, wherever the respiratory murmurs are not masked by the ronchi, they present a considerable increase of their intensity and duration, affecting the expiratory in particular.

2°. A little of the dry character in the murmurs where they are not masked by the ronchi.

3°. Posteriorly and inferiorly at both sides, the sub-crepitant ronchus with fine bubbles, resembling the primary crepitant ronchus of pneumonia, existing almost exclusively in inspiration.

4°. In the postero-superior parts, and in some points of the anterior regions, dry bronchial ronchi both acute and grave, but especially acute, of moderate intensity and coexisting more particularly with inspiration.

2nd *stage*.—1°. The inspiratory and expiratory murmurs presenting every where the exaggerated character, even in the most depending parts posteriorly; but this exaggerated character of the normal sounds appearing more uniformly in different points of the chest; remaining always more marked in front than behind.

2°. The humid character replacing more or less the dry, and sometimes passing even to the viscid.

3°. Humid bronchial ronchi with bubbles more numerous, but finer and more regular at the postero-inferior part of the chest.

§ III. CHRONIC BRONCHITIS.

It is sufficient, for all practical purposes, to distinguish two varieties; one in which the mucous secretion is increased, the other in which it is diminished or entirely suspended. The numerous species admitted by Laennec, are but forms or different degrees of these two types.

I. *Chronic bronchitis with increased mucous secretion.*

1°. Slight decrease of the duration, and still more of the intensity of the inspiratory murmur; increase of both the intensity and duration of the expiratory. These characters are most marked posteriorly. In front the decrease in inspiration is usually less sensible.

2°. Character of difficulty of production in the inspiratory and expiratory murmurs, especially in the former.

3°. Humid character of these murmurs, proportioned to the abundance and fluidity of the secreted mucous matter.

4°. Humid or mucous bronchial ronchi with large bubbles, mixed here and there with dry bronchial ronchi, which are chiefly grave, and which coincide especially with expiration.

II. *Chronic bronchitis with decrease or complete suspension of the mucous secretion.*

1°. Sometimes great decrease of the inspiratory and expiratory murmurs, which may fall as low as 1. This remarkable decrease is perceptible over the entire chest. More frequently, considerable decrease of the intensity and duration of the inspiratory; the expiratory being very little increased in intensity, but very much in duration.

Frequent variations in these characters.

2°. Character of remarkable difficulty of production in both murmurs; character of dryness and hardness.

3°. Dry bronchial ronchi, especially the acute toned, almost equally audible during both periods of respiration; these ronchi are more or less intense, more or less acute in their tone, according to the degree of tumefaction and of morbid change in the bronchial mucous membrane.

§ IV. DILATATION OF THE BRONCHI.

1°. Decrease of the intensity and duration of the inspiratory murmur, which may fall to 6 and 5. Increase of the intensity and duration of the expiratory, which may rise to 12 and 15.

2°. All the alterations of *quality*, from the simple degree of clearness up to the cavernous character, appear in succession, and extend from expiration to inspiration, in proportion as the disease passes from its earliest to its most perfect forms. These alterations of *quality* express tolerably well by their degree, 1°. the degree of induration of the pulmonary tissue round the dilated bronchi; 2°. the degree of this dilatation.

3°. All the humid bubbling ronchi comprised between the simple mucous ronchus and the cavernous ronchus, may be observed in dilatation of the bronchi; their degree represents the degree of dilatation.

Well marked cavernous ronchus always indicates, in such cases, very considerable partial dilatation.

4°. Voice bronchophonous or pectoriloquous, according to the degree of bronchial dilatation and of induration of the surrounding parts.

5°. Bronchial or cavernous cough according to the degree of developement of these two conditions.

§ V. CONTRACTION OF THE BRONCHI.

This diminution of caliber, which may arise from a variety of causes, is sometimes general and nearly uniform, sometimes partial and confined to a single bronchus; in the latter case it may occur in a principal or in a secondary ramification. In both cases it may exist in different degrees. The auscultatory symptoms vary a little according to those two circumstances.

I. *Contraction of the bronchi nearly general and nearly uniform.*

1°. Very marked diminution of the inspiratory and expiratory murmurs, but especially of the former; the degree of diminution expresses exactly the degree of contraction. These characters are met in all parts of the chest: sometimes we find that the diminution of the expiratory murmur affects its intensity only, and that its duration appears augmented. Frequent variations in these characters, when the bronchial contraction depends on tumefaction of the mucous membrane without chronic induration.

2°. Character of great difficulty of production in the inspiratory and expiratory murmurs.

3°. Character of dryness and of hardness in these sounds.

4°. Transmission, in a slight degree, of the buccal, nasal, and pharyngeal respiratory sounds through the pulmonary tissue.

5°. Dry bronchial ronchi, acute and grave, but chiefly the former, occurring alike in both periods of respiration; their intensity being proportional to the degree of contraction.

II. *Partial contraction confined to a single bronchus.*

1°. Complete cessation of both respiratory murmurs in the lobules, the lobes, or the lung to which the obliterated bronchus is distributed*; or if the obliteration be not complete, diminution merely of these sounds, proportioned to the contraction. It is important to recollect that, in this case, the cessation or diminution of the respiratory murmurs is limited to the part to which the obliterated or contracted bronchus is distributed.

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* We know, in fact, that each branch furnished by the principal bronchial tube is distributed to a distinct lobule, and does not communicate with the neighbouring ones, whose place, therefore, it cannot supply.

2°. Exaggeration of the respiratory murmurs in the opposite healthy lung, or in the parts of the diseased one to which the sound bronchi are distributed.

3°. If there be merely contraction, the ear feels the sensation of great difficulty in the passage of the air through the bronchial tubes, in the points where the preceding characters are heard.

4°. Character of dryness and of hardness in the respiratory sounds.

5°. Transmission of the buccal, nasal, and pharyngeal respiratory sounds through the portion of lung in which considerable diminution or complete cessation of the normal respiratory sounds exists.

6°. Very strong sibilant ronchus, existing almost equally in expiration and inspiration, and heard precisely in those points of the lung where the respiratory murmurs are very much weakened or completely extinct. Well marked diminution of this ronchus in proportion as we recede from that part of the lung.

7°. If it is the main bronchus of one lung that is contracted by the pressure of a tumour, we hear at the root of the lungs, when the patient speaks, "a peculiar sound, analogous to egophony or bronchophony*." "This sign," adds M. Reynaud, "when it exists independently of those of pneumonia or pleurisy, is of great value in the determination of this state of compression of one of the bronchi." "With this sign is joined a marked diminution in the force of the voice, which appears as if smothered†."

ARTICLE II.

DISEASES OF THE PULMONARY TISSUE.

§ I. PULMONARY EMPHYSEMA.

The most accurate auscultation detects no symtomatic difference between vesicular and interlobular emphysema. I have elsewhere shown that Laennec was mistaken in considering the friction sound of ascent and descent, and the dry crepitant ronchus with large bubbles, pathognomonic of interlobular emphysema.

1°. Gradual diminution of the inspiratory murmur from 10 to 2 or even 1, according to the degree of the emphysema and the length of time it has existed; this diminution affects both its intensity and duration; considerable increase of the intensity and still more of the duration of the expiratory murmur, from 2 to 10, 15, 18, 20. These characters exist in the whole extent of the chest, or in one side of it only; their greatest intensity is found in front.

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* Reynaud, Dict. de Med. 2 edit. tome 6, p. 25.

† *Ibid. tome 6, p. 26.*

2°. Character of roughness, hardness, difficulty and dryness in both respiratory murmurs.

3°. Dry bronchial ronchi both grave and acute; more grave in proportion as the period of an attack of the intercurrent bronchitis that complicates emphysema is more remote; more acute in proportion as this bronchitis itself is more acute. These ronchi are almost equally audible during inspiration and expiration, and manifest themselves wherever the preceding characters exist.

4°. Mediate or immediate auscultation of the voice, of the cough, and of the sounds of the heart, shows that the transmission of these sounds through the emphysematous pulmonary tissue is much more imperfect than in the normal state, and is inversely as the degree of emphysema.

5°. Increase of the normal resonance on percussion, with a somewhat tympanitic character in the sound; percussion communicates to the finger a sensation of very great elasticity. These characters are found even in the precordial region.

6°. Diminution of the normal thoracic vibration which is perceived by the hand applied to the chest while a person speaks. This decrease of the vocal vibration is proportional to the degree of emphysema, and is especially manifest in the anterior regions.

7°. Rounded form of the chest, which tends more and more to assume a spherical shape; protrusion of the intercostal spaces, and of the infra and supra-clavicular regions. All these characters are proportional in their developement to the degree of emphysema and to the time it has existed.

8°. The exterior movements of the chest in the emphysematous having been but little attended to, I will dwell more on them than on the other morbid characters presented by this class of diseases. These motions are quite characteristic of pulmonary emphysema.

Inspiration is abrupt and short, produced by a kind of convulsive movement in which the entire thorax, as a single piece, is forcibly elevated, the infero-lateral parts of the chest almost alone affecting the movement of dilatation; more or less depression of the supra-sternal fossa and supra-clavicular regions; the mean duration of this movement may be represented by 3.

Expiration seems to be nothing more than relaxation of the muscles previously violently contracted; it is produced by the gradual sinking in of the thorax; its mean duration may be represented by 9.

Almost complete abolition of the partial movements of the chest (movements by which the ribs are separated and approximated), which no longer moves, either in inspiration or expiration, except by a motion of the whole.

The characters I have just described represent a very advanced state of emphysema: their degree of developement is directly proportional to that of the disease. (29)

§ II. PULMONARY ŒDEMA.

It may exist under two very distinct forms: 1°. the acute, 2°. the chronic form. The second, consecutive to other diseases; the first, originating independent of every other affection.

I. *Chronic or passive œdema.*

1°. At the posterior part of the chest, diminution of both the inspiratory and expiratory murmurs, which augments as we descend to the most depending parts of the lungs, where the œdema is always greatest. The diminution of the inspiratory murmur is proportionably much more considerable than that of the expiratory, which is scarcely perceptible except where the œdema has reached its maximum. Where their diminution is greatest, the two murmurs may be represented by the number 1 or ½ common to both.

2°. Humid character of the respiratory murmurs, particularly well marked where neither has as yet suffered any great diminution. This humid character has nothing of viscidity combined with it.

3°. Humid, vesicular, bubbling ronchus; the bubbles fine, distinct, rounded, succeeding each other with tolerable regularity and without precipitation, not always uniform, not numerous, free in their developement, leaving an impression of humidity unmixed with viscidity, appearing in the depending parts of the lungs posteriorly, and coexisting with inspiration alone.

4°. A little bronchophony in the most highly marked cases.

5°. A little diminution of the resonance on percussion.

6°. A little diminution of the vocal vibration.

These morbid characters usually occupy the posterior depending parts of both lungs, or of one only, and may be transferred alternately from one to the other, or even to the anterior inferior parts, according to the mode in which the patient lies.

When passive sanguineous congestion is added to the serous congestion, as occurs in most cases where there is an obstacle to the circulation in the heart or lungs, the characters are the same, with this difference alone, that the humid character of respiration tends to become viscid, and that in the ronchus above described the bubbles are more humid and more voluminous.

II. *Acute or active œdema.*

A man, in the vigour of life, was admitted into hospital in 1836, under *the care of* M. Andral, for an attack of acute painful œdema of the lower limbs; the œdema disappeared, and at once all the cerebral symptoms that result from sudden and abundant effusion into the pia mater made their appearance. These again passed away, and were succeeded by extreme difficulty of breathing, which occurred suddenly, and increased with very great rapidity; the serous determination which had fallen on the lungs, extended to the trachea, the larynx, and at last the mouth; inspiration and expiration became whistling, the tongue acquired an enormous volume, the soft parts of the neck were tumified and very tense; this tumefaction was white and very painful. However, these symptoms also disappeared, and we began to anticipate the recovery of the patient, when suddenly all the symptoms of intense peritonitis set in. He sank rapidly, and we found on examination, the justice of our diagnosis. We had, in fact, considered the disease an acute œdema attacking in succession the cellular tissue of the inferior extremities, of the pia mater, of the lungs, of the trachea, of the larynx, of the mouth, of the tongue, and of the sub-peritoneal regions. During the invasion of the lungs we investigated the auscultatory signs, and found the following:

1°. Diminution of inspiration and expiration, to such an extent, that the former had sunk to 2 and the latter to 1, in the postero-inferior parts of the chest; in proportion as we receded from these parts, inspiration and expiration assumed their normal standard, and even presented, especially in front, the supplementary character.

2°. The humid character somewhat viscid, as compared with passive œdema.

3°. Not more than one or two bubbles of the ronchus of passive œdema, even in the deepest inspirations, and their developement more difficult and more imperfect.

4°. Marked dullness on percussion.

5°. Bronchophony.

6°. Diminution of the vocal vibration.

These characters existed in the posterior depending parts of the lungs only. They diminished and disappeared in proportion as we receded from these points.

The organic alteration of the lung, as found at the autopsy, that is, at a period when it must have greatly diminished, consisted in condensation of the pulmonary tissue, produced by a kind of intimate union of this tissue with a somewhat viscid serosity; it was a sort of white engorgement.

§ III. ACTIVE SANGUINEOUS CONGESTION OF THE LUNGS.

Occupied for a long time in clinical investigations on auscultation, I carefully noted the results furnished by it in each new case that came into the wards; and afterwards observed attentively the changes that occurred in the respiratory sounds. I have thus remarked a certain group of symptoms, which attracted my attention from the constancy and regularity with which the morbid characters that compose it were found combined; these characters were different from any described by Laennec; they varied in their degree of developement only. I sought to discover to what lesion they corresponded. I had first seen them appear as the first symptoms in some cases of pneumonia developed under my own eyes. They preceded those given by Laennec, as characterizing the first stage of that disease; they were as if the heralds of its approach. I met them afterwards, precisely the same, in some persons admitted into hospital labouring under general sanguineous plethora, and sanguineous congestion of the brain or some other organ. They disappeared readily, in this last class of cases, under the influence of general depletion. They seemed, in some cases, to alternate with the signs of cerebral congestion; they disappeared along with the symptoms of sanguineous plethora. In persons that presented this group of symptoms during life, we found after death that there was a difference between the anatomical characters corresponding to it, and those that correspond to the signs of the first stage of pneumonia. Thus, pathological anatomy, the progress of the affection, its general symptoms, the regularity and constancy of the morbid characters that constitute the local signs, the frequent consecutive developement of pneumonia, all proved that they belonged to a peculiar affection, and that this was a sanguineous congestion of the lung, analogous to that which takes place in the brain and in all the systems of the economy; a congestion by no means like that which occurs in the depending parts of the lungs when any obstruction to the pulmonary circulation arises, but a congestion essentially *active*, resulting from a superabundance of blood, from an increased energy in the forces that circulate it, and from a vicious direction given to those forces.

Some practical facts are connected with the knowledge of this morbid state: 1°. in some cases it enables us to recognize pneumonia before the manifestation of the symptoms which characterize the period regarded by authors as the first stage of this disease; hence it leads to a preventative treatment of pneumonia; 2°. it reveals the cause of that state (sometimes very distressing) of dyspnœa, of vague oppression, of uneasy feeling in the chest, of stuffing, of excitation and general disturbance in the circulating system which some patients experience, without our knowing in the actual state of science, what opinion to adopt as to the nature of their malady; 3°. this study is a fragment of the general study of active sanguineous congestions of the different viscera of the economy, a subject still much neglected.

I have taken an accurate account of the cases of 23 patients affected with the disease I have described; it is those 23 cases, analyzed in all their parts, that have guided me in tracing the history of active sanguineous congestion of the lungs. I shall confine myself here to an exposition of the general facts that constitute this history, with the intention of publishing elsewhere a complete memoir on this subject.

Etiology.

1°. *Age.*—The period of life comprised between 17 and 25, is that which appears to predispose most to active sanguineous congestion of the lungs; that at least which has furnished most of my cases. If we compare this result with that obtained by authors in their statistics of pulmonary hæmorrhage and of diseases of the lungs, we will find that there exists an intimate connexion in this respect, between these three morbid movements, congestion, hæmorrhage, structural change. There is the most complete harmony between the periods of life which each selects for its developement; the epoch of congestion is the first, then follows that of hæmorrhage, and later still that of organic formations. This is, in fact, the pathogenic order most generally observed and recognized. It is obvious from this, of what practical importance the diagnosis of active sanguineous congestion of the lungs may be.

2°. *Sex.*—The influence of sex, if it have really any influence in the developement of sanguineous congestion of the lungs, appears to arise from the uterine functions. In three of my cases, the pulmonary congestion followed sudden suppression or diminution of the menses.

3°. *Constitution.*—The muscular constitution, the sanguineous temperament, are the most favourable to the developement of active pulmonary congestion. That peculiar form of the lymphatic temperament, that feeble constitution, which usually coincides with the developement of phthisis pulmonalis, appears to hold the second place.

The professions do not seem to have any influence on the developement of this affection.

4°. *Hereditary influence.*—The same general sanguineous plethora, the same tendency to visceral, and especially cerebral congestion, existed in the families of most of my patients.

5°. *Influence of former diseases.*—A third of my patients had had catarrhs; a less number had been long subject to symptoms of cerebral congestion (1st form of M. Andral). This tendency to cerebral congestion had generally diminished and disappeared, in proportion as the tendency to pulmonary congestion was developed.

6°. *Influence of season.*—In many of my cases atmospheric heat appeared to have some influence upon the developement of the affection; for a greater number of cases occurred in July than in any other month.

7°. Long continued efforts, asphyxia by carbonic acid gas, long exposure to a burning sun, appeared to have produced it in four cases.

In conclusion, we have no etiologic circumstance, whose direct influence, whose universality, and predominance over others is distinctly marked—no dominant cause.

Symptomatology. 1°. *Local symptoms.*—*Auscultation* furnishes: *a*, the character I have elsewhere described under the name of the humid viscid character. It existed in all the cases.

b. A marked diminution of both the respiratory murmurs; a diminution nearly proportional in each, inspiration having fallen to 4 or 5, expiration to 1.

c. The ronchus I have described (see 1st part, Ch. II. Art. XI.) as the humid ronchus with continuous bubbles.

d. Slight dry cough, not accompanied in any part of the chest by the usual signs of bronchitis.

e. Feeble bronchophonic resonance, but only in cases where the congestion has attained a high degree.

Slight dullness on *percussion*, when the congestion is rather considerable.

Slight diminution of the *vocal vibration* is perceptible in some rare cases, (those only where the congestion has reached its highest degree.)

In all the cases the breathing was strikingly accelerated, and the face presented the expression of difficulty of breathing well marked.

Whenever the pulmonary congestion was not actually complicated with pneumonia, the characters of the expectoration were constantly the following: sputa scanty, white, almost as much mingled with air as in the natural state, remarkable for a slight degree of viscidity. In 18 cases out of 23 cases they presented these characters.

Stitch in the side, or pleuritic pain, is not one of the symptoms of active pulmonary congestion; in the cases where it occurred, it depended on pleurisy or pleuropneumonia complicating this affection.

On the other hand there is a sign that seems essentially connected with the presence of congestion; it is a feeling of tightness and stuffing in the chest. This sensation is very troublesome; it keeps the patient in a state of restlessness and anxiety, that increases the oppression and state of general agitation. Sometimes this sensation has been felt in the parts occupied by the congestion, sometimes elsewhere. It differs altogether from the pleuritic pain known by the name of stitch in the side.

By means of these signs, we can easily circumscribe the space in which the congestion exists. At the same time, the boundary between the healthy and diseased parts is never abrupt. It is only by degrees, and as we recede from the centre of the congestion, that the respiration resumes its normal characters; farther on, and throughout the remainder of the lung, it is puerile.

2°. *General symptoms.*—Countenance animated, skin every where vividly coloured, expression of general plethora, well marked heat of body, but not febrile heat; such was the general aspect of most of the patients. In all cases where sanguineous congestion of the lungs alone existed, we remarked, instead of fever, a state of strongly marked general excitation.

From my observations, the *chosen seat* of congestion is the middle third of the posterior parts of the lungs; it may, however, fix upon any other part of those organs; I have seen it occupy the upper third, the middle and the lower third of the anterior region. The seat of the congestion may vary in the course of its different stages; it may extend, decrease, pass from one point to another, return to its primary seat, &c. But I have not seen these changes, any more than the primary seat of the affection, influenced by the decubitus of the patient; I have never seen it appear, such as I have described it, in patients long bed-ridden, who have fallen into that anemic state that disposes to passive or hypostatic congestions. There is nothing determinate as to the extent it may occupy.

Peculiar diagnosis.—1°. Whenever the humid viscid character, the humid ronchus with continuous bubbles, diminution of the murmurs, especially the inspiratory, feeling of oppression, expectoration white, mucous, ærated and a little viscid, distinct sensation of stuffing in the chest, state of general sanguineous plethora, with almost complete absence of febrile excitement are found united, we may rest assured that there exists active sanguineous congestion in the part of the lungs where the above physical signs are recognized.

2. This diagnosis will still be warranted, though there exist a state of febrile excitement, whether this state be or be not explained by some existing complication.

3. If only the viscid humid character, the fall of the respiratory murmurs, especially of the inspiratory, and the humid ronchus with continuous bubbles, be distinctly recognized, there will still be enough to assure us of the presence of this affection. But without this combination of signs, we cannot, I think, attain physical certainty in our diagnosis.

Differential diagnosis.—1°. *From the first stage of pneumonia.*—Active sanguineous congestion of the lung being sometimes only a preparatory step to the first stage of pneumonia, being indeed but the first degree of that disease, it is plain that at the point of contact of these two morbid states, it will be no longer possible to find any difference between them, either in their symptoms, or their morbid anatomy. But in the perfect form of either, they are distinguished by the difference between the humid ronchus with continuous bubbles and the primary crepitant ronchus, by the absence of the febrile state and the humid viscid character observed in congestion, lastly by the difference of the sputa.

2°. *From acute capillary bronchitis in its first stage.*—The diminution of the respiratory murmurs is less in bronchitis than in congestion. Its ronchus is different from the humid ronchus with continuous bubbles (see chap. II. art. XI.); the viscid humid character of congestion is replaced in it by the character of dryness and hardness; some sibilant ronchi are audible here and there; there is no expectoration and the febrile state is well marked. Active sanguineous congestion is rarely double; it may exist in any part of the chest; capillary bronchitis is always double; its signs seldom exist except in the infero-posterior regions. This differential diagnosis becomes in some cases very difficult: in fact, intense capillary bronchitis is often accompanied by considerable sanguineous congestion of the posterior depending parts of the lungs*; in this case, the signs of the two affections are combined, and we generally come to suspect the existence of both. *In the second stage of bronchitis*, the differential signs between the two affections are numerous: there is the absence of diminution of the respiratory murmurs, the difference of the ronchi, the localization of the signs of congestion and the universality of those of bronchitis, the different course of the two diseases.

3°. *Passive œdema of the lungs.*—The exclusive seat of passive pulmonary œdema at the base of the lungs, its existence in both sides at once, the influence of the decubitus of the patient on its position, the characters of the ronchus that accompanies it, the absence of the viscid character, the circumstances in which it is observed, are quite sufficient to distinguish it from congestion.

4°. With respect to *acute œdema of the lungs*, the differential diagnosis of it from congestion must be very difficult: the absence of the humid continuous ronchus, the peculiar course of the affection, the manifestation of serous congestion in other parts besides the lungs, are the only differential signs upon which we can reckon. But we must not forget that acute pulmonary œdema is a very rare disease, and that it is in general accompanied with fever, whilst sanguineous congestion is tolerably frequent, and when simple is unattended by fever.

5°. *Active and passive sanguineous congestions of the lungs.—Parallel between them.*—The one is obedient to physical influences and is modified by the mode in which the patient lies and the depending position of the parts; the other is only influenced by the laws of the temporary organic disturbance that has invaded the circulating system and directed its force upon the lung in particular.

The one is developed in the most asthenic states of the economy and only appears in the depending parts of the lungs; the other is developed essentially in sthenic states, and may occur in any part of these organs.

The one is produced slowly, remains long stationary, and is not resolved but with the greatest difficulty. The other is usually sudden in its invasion, rapid in its course, and rapidly removed when suitably treated.

Active sanguineous congestions of other viscera, especially of the brain, often accompany active congestion of the lungs, but scarcely ever the passive congestion of these organs.

The one is the result of those circumstances that produce excitement of the circulatory movements; the other of those that enfeeble them.

Active pulmonary congestion is to the passive form, what ordinary cerebral congestion is to the cerebral congestion produced by some obstruction to the return of the blood by the jugulars. The active congestion seems to be essentially arterial, the passive essentially venous, as well in the lungs as in the brain.

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* Autopsies made in the acute period of capillary bronchitis complicated with pneumonia of one of the lungs.

They differ in their local symptoms as in their general aspect. In passive congestion the ronchus is large and very humid; it resembles the ordinary mucous ronchus; it exists both in inspiration and expiration; the humid character of the respiratory murmurs is somewhat coarser; it seems as if respiration took place in a muddy liquid; the sound on percussion is usually very obscure; the vocal vibration is lost in these points; we sometimes hear slight bronchial character, which depends on a commencement of splenization; if the ear be applied to the patient's mouth we hear the fine bubbling ronchus, described elsewhere as the bucco-pharyngeal ronchus; there is none of that peculiar feel of stuffing in the chest mentioned in the description of active congestion; the expectoration is catarrhal or sometimes indeed of a brick-red colour, which is quite peculiar.

Invasion.—In six of my cases of active pulmonary congestion, the attack was abrupt and rapid, as in cerebral congestion; it was the apoplectic stroke of the lung: sudden and considerable oppression, a sense of stuffing and difficulty of breathing, feeling of general fullness, usual local symptoms, and then a state of general uneasiness, of agitation, of lassitude. But the disease did not begin in this way except when it was free from all complication. In the majority of cases, the symptoms of congestion appeared after some days of previous indisposition. In some instances, sanguineous congestion of several viscera existed together; for some time one or other alternately had the ascendant; but, after several alternations of this kind, the signs of pulmonary congestion appeared and attained, at the expense of the rest, marked pre-eminence and permanence.

Forms, course, duration.—Active sanguineous congestion of the lungs appears under two principal forms, and its course is different in each; 1°. in one, the determination to the lung is the result of some organic change going on there. In this case the determination, like its cause, is steady, slow, gradual. 2°. In the other form, on the contrary, where nothing in the lung keeps up the determination, where it is influenced by no law but the kind of momentary irregularity into which the circulation happens to be thrown, it is abrupt, rapid, changeable, passing by starts from one point to another; in a word, it exhibits the character of the disorder upon which it depends.

The duration of this affection is in general dependant on the form in which it appears. It is usually between 10 and 15 days, when the congestion is of the second form and quite free from complication; its duration is much more considerable and extremely variable when any complication, especially organic disease of the lung, exists.

Terminations.—We have recognised three modes of termination;

1°. hæmorrhage; 2°. pneumonia; 3°. resolution. Reasoning from analogy we may admit a fourth, consecutive organic formations; but, in the actual state of science, we cannot say any thing of the forms or the nature of these organic alterations, which indeed we only admit as possible.

1°. Hæmorrhagic congestion may occur in two different forms: sometimes it bursts forth in the midst of the pulmonary tissue, which it breaks up as it would the brain,—this is pulmonary apoplexy; sometimes it tends to resolution by a sanguineous exhalation on the surface of the bronchi,—this is bronchial hæmorrhage. Sometimes also both effects are combined; this almost always occurs in pulmonary apoplexy.

2°. Active sanguineous congestion of the lung, if left to itself, does not necessarily terminate in pneumonia, as one might be disposed to think: pneumonia is only one of its natural modes of termination; it seems, indeed, to be the most common, for it took place in 11 of my 23 cases. It is probable that pneumonia is always preceded by the signs of active sanguineous congestion, and that if these have not been as yet described, this arises, as well from our seldom having an opportunity of seeing the disease in its earliest phases, as from the delicacy of these signs, and the auscultatory experience requisite to detect them.

On two occasions, while entrusted for a time by M. Andral with the care of the wards St. Leon and St. Michael at la Pitie, I made the following experiment, as harmless for the patients as conclusive of the question at issue. Two patients, of nearly the same strength, the same habit of body, and almost the same age, were admitted to hospital; I recognized in both the signs of pulmonary congestion; they were likewise recognized by the students; I directed one to be bled, and the other to have merely some demulcent; stating at the same time that the signs of congestion would probably have disappeared in the first on the following day, and in the second be changed into those of pneumonia. The next day, in fact, the one that had been bled had scarcely a trace of the signs remarked the day before; while every one could recognize, in the case left to itself, the signs of pneumonia (crepitant ronchus, bronchial respiration, rusty-coloured sputa, &c.) A second opportunity occurred for repeating the same experiment in nearly similar conditions: the result was precisely the same. Amongst the students, those who were practised in auscultation recognized themselves a marked difference between the symptoms of congestion and those of the pneumonia that followed it. There was no difficulty in arresting the pneumonia thus developed under our eyes. It is easy to see what advantage we may gain in practice from a knowledge of the signs and course of active sanguineous congestion of the lungs. In those cases of mine where the congestion was transformed into pneumonia, it was in general about the 7th day of the congestion that this transformation took place.

3°. Active sanguineous congestion of the lung is a distinct disease, independent of every other, having its peculiar course, duration, symptoms and modes of termination. The termination by resolution was the most frequent in my cases; it takes place by a successive degradation and gradual disappearance of the symptoms. This degradation and disappearance occur in the following manner: the bubbles of the ronchus become more humid, more voluminous, less frequent; then they cease. The humid character of the respiration becomes less and less marked, and so disappears. The respiratory murmurs increase continually, pass soon the normal standard, and assume the exaggerated character in the very place in which they were diminished. The phenomena furnished by the sense of touch and by percussion disappear first; those derived from auscultation last.

Prognosis.—No very unfavourable prognosis is connected with this affection, when it is simple. If it circumscribe a pneumonia, and if it spread in the same direction in which the pneumonia has successively advanced, the prognosis becomes very serious, because this indicates the tendency of the pneumonia to continue to extend. In phthisis pulmonalis, if it appear very often, and especially if it persist very long in the same place, we must fear hæmoptysis, and besides we will have reason to think that the organic change of the lung is become both more severe and more rapid. If it is frequently renewed in the supero-anterior regions of the chest, and if a suspicion of phthisis is created by other circumstances, it may lead us to presume that there is a tendency to tuberculization in those parts, or that it has already commenced.

Pathological anatomy.—The exact anatomical characters of active sanguineous congestion of the lung are as yet undetermined. An accidental death from some other cause, during the existence of a pulmonary congestion, can alone furnish them; and such a case must necessarily be long wanting. One of my patients sank rapidly of a pneumonia, which had been preceded, in every point it successively attacked, by active sanguineous congestion: we had noted carefully, during life, the parts of the chest where the signs of congestion and the signs of the 1st or 2nd stage of pneumonia existed; at the autopsy we compared the anatomical characters of these different points, and the following was the result:

Congested part.	*Inflamed part.*
1°. Floated in water, half above, half below the surface.	1°. Sank rapidly to the bottom of the water.
2°. Compressible and not friable. Presenting no friability, that is, no readiness to tear, except what depended on its increased density; for after the removal of much blood by washing and moderate pressure, its friability disappeared.	2°. Incompressible and friable.

3°. By washing and compression, its flaccidity, its resistance, its elasticity, and its normal volume could be nearly quite restored.	3°. It was impossible to obtain the same result in this case.
4°. On compression, blood somewhat thick, unmixed with purulent matter, escaped in tolerably large quantity; it was distinctly red, and divided into two parts, one molecular, composed of the coloured particles suspended in the other part, which remained liquid.	4°. A kind of sanio-purulent liquid exuded in very small quantity by compression: a marked change, a kind of organization or solidification of the blood effused or exhaled.
5°. A kind of semi-softness, of semi-flaccidity.	5°. Firm, resistant, solid.
6°. Vivid redness; air bubbles in considerable quantity.	6°. Dusky redness, approximating a little to tan colour; complete absence of air.
7°. No granulations.	7°. Reddish, fleshlike granulations, very distinct.

There was not any absolute line of demarcation between the two parts; an insensible degradation of the preceding characters conducted from the one to the other.

The pathological appearances given in the first column, cannot be considered as exactly the type of active sanguineous congestion of the lungs, because they must necessarily be affected by the proximity of the pneumonia, and the gradual fusion of their mutual anatomical characters. I make this remark in order to anticipate the objections that may be made to those characters.

Intimate nature of the disease.—Nothing is better calculated to enable us to comprehend the intimate nature of pulmonary congestion, *in its simple state,* than the complete absence of every inflammatory element. Hence the facility with which it appears and disappears, its duration so brief in some circumstances, its course so rapid, so capricious; for example, when it alternates with congestions of other viscera. In the simple state I am supposing, the disease is rather a modification of *motion* than of *matter;* that is, of the forces that communicate to the blood its natural impulse and direction, than of the organ that receives the blood, or of the blood itself. Let the vicious impulse cease, or let it be directed upon another organ, and the lung at once resumes its natural state. It is only when this determination of blood to the same tissue is very often repeated, that it can produce in its functions or in its texture, organic changes more or less profound. In support of what I have said as to the absence of any inflammatory element in active sanguineous congestion, we may remark the difference between the blood drawn in cases of simple sanguineous congestion, and in cases complicated with pneumonia; in the latter it always presents a tolerably thick inflammatory crust; in the former there never is a trace of this, but merely the large, solid, resisting clot, with little serosity, which is usually met in patients of very sanguine temperament, who have had recourse to bleeding to obviate the effects of general plethora and cerebral congestion.

Treatment.—Studied with a view to its treatment, active sanguineous congestion of the lungs presents very different indications, according as it is simple or compound. It presents also remarkable differences in this respect, according to the nature of its complications.

1°. General bleeding is the best therapeutic means we can employ in this disease, when it exists in the *simple state;* it is that which has succeeded best with me. One blood-letting has sometimes been sufficient to dissipate it; at other times two were required. The congestion may reappear several times in succession, notwithstanding the employment of the lancet. In the majority of cases, when the disease is quite simple, rest, some trifling diluent internally, and mustard foot baths are sufficient to remove it in a very short time, generally, in my cases, in from 6 to 7 days.

The signs of general plethora and excitement that existed in the patients treated in this way, disappeared along with the signs of pulmonary congestion; all returned gradually and quickly to the normal state; and yet this simple treatment did not diminish the mass of blood; its influence appeared to be exercised on the movement by which this fluid was agitated. This is another reason for thinking that pulmonary, like other visceral congestions, consists essentially in a peculiar disturbance of the circulation of the blood, without any alteration either in this fluid, or in the tissues to which it is determined. An augmentation of the general mass of the blood is apparently very favourable to the developement of partial congestions; but by itself and without the aid of the preceding cause, it can only produce general uniform congestion, that is, a state of sanguineous plethora; and indeed in all my cases of congestion, in which this temperament was well marked, this state of general plethora existed. But partial congestions may easily occur without any augmentation of the mass of the blood; the disturbance of the circulation, and its direction upon a single point are sufficient to produce them. It will be remembered, that in speaking of the etiology of congestion, I said it manifested itself chiefly in persons of very sanguine temperament, but that it might also be developed in individuals of an entirely different constitution.

2°. When congestion is complicated with pneumonia or any other affection, the treatment belongs to the latter, and hence it becomes useless to speak of it.

The limits of this work do not permit me to give more than two cases of active pulmonary congestion: they will be seen at the end of this chapter. (30)

§ IV. Passive sanguineous congestion of the lungs.

See the exposition of the symptoms given at page 162, in speaking of active sanguineous congestion.

§ V. Pulmonary apoplexy.

It seldom happens that pulmonary apoplexy is not accompanied by active sanguineous congestion. In this case, the signs of congestion are found all round the apoplectic clot; and we then recognize the following signs.

1°. Considerable diminution of both respiratory murmurs in a very limited space. In some cases there is almost complete cessation of them.

2°. All round this circumscribed spot, signs of active pulmonary congestion; a little farther on and in the remainder of the chest, supplementary respiration, more distinctly marked the nearer we approach the affected part.

3°. Considerable obscurity or even complete dullness on percussion where the diminution or cessation of the respiratory murmurs exists.

4°. Bronchophonic resonance of the voice in the same place. Diminution of the vocal vibration is also sometimes sensible.

5°. Expectoration tinged with blood.

6°. Sensation of stuffing and of great difficulty in respiration.

7°. With respect to the crepitant ronchus, which Laennec has described as existing at the seat of the apoplectic nucleus, and the mucous ronchus which he has said is audible at the root of the lungs, I confess that, in several cases, which on autopsy presented one or more apoplectic nuclei, I only found the crepitant and mucous ronchi for a short time after the appearance of the hæmoptysis, and observed them disappear along with it; which makes me think they belong rather to hæmoptysis than to pulmonary apoplexy. If, at the same period, the ear be applied to the patient's mouth, we have the bucco-pharyngeal ronchus which I have elsewhere described.

§ VI. Pneumonia.

We can recognize two principal forms of pneumonia: acute and chronic.

I. *Acute pneumonia.*—Sometimes it is *lobular;* this is the form in which it usually appears in children. Sometimes it occupies uniformly a greater or less extent of the pulmonary tissue.

In the latter case we have the following signs on auscultation.

1°. In the first stage, diminution of the inspiratory and expiratory murmurs, which are reduced to 4 or 2 and 1; in the second and third stages, complete cessation of the respiratory murmurs, which are replaced *by alterations of quality.*

2°. Alterations of *quality* commencing with the clear character, which appears first in expiration only, extends afterwards to inspiration, and gradually increases till it becomes well marked bronchial character. During the period of resolution, the preceding alterations of *quality* repass successively, in their gradual decrease, through all the degrees they have passed over in their period of increase, and do not disappear from expiration till after they have ceased in inspiration. Complete correspondence between the degree of disease and the degree of alteration of *quality*.

3°. Primary crepitant ronchus appearing in the first stage; usually coexisting with the lower forms of alteration of *quality*; disappearing in the second stage when the higher forms of these alterations appear; coexisting with inspiration only; appearing to change during the third stage, at least in some cases, into a mucous ronchus with humid, rather voluminous bubbles, the special character of which is that they coexist with inspiration alone; lastly, at the period of resolution, the crepitant ronchus appears in the form of somewhat larger, more humid and less regular bubbles, which coexist also a little with expiration.

The other symptoms are well known. I may mention among them the decrease, sometimes almost complete cessation, of the vocal vibration at the part occupied by the disease.

In *central* pneumonia it often happens, notwithstanding what Laennec has said, that all the local signs are wanting, and that we have nothing to guide us in our diagnosis but the characters of the sputa, and the general symptoms. I have myself seen 5 or 6 cases of this kind. MM. Andral*, Louis†, Chomel‡, &c. have often observed this absence of local phenomena in central pneumonia.

In *lobular* pneumonia we find on auscultation: 1°. Exaggeration of both murmurs (supplementary respiration) affecting expiration much more than inspiration. Sometimes we even find, in the same patient, and in the same parts, diminution of the inspiratory and augmentation of the expiratory murmur. These characters diminish and disappear in proportion as we recede from the point where the pneumonia exists.

2°. Expiration usually presents the clear, blowing *quality*, sometimes a very slight degree of the bronchial, but in general the alteration of *quality* goes no farther.

3°. Occasionally we meet here and there, towards the end of inspiration only, some scattered, inconstant bubbles of the primary crepitant ronchus.

4°. No change is perceptible in the sound on percussion, nor in the vocal vibration.

II. *Chronic pneumonia.*—Many persons have questioned the existence of chronic pneumonia; some have admitted it, but as an exceedingly rare affection. M. Andral* considers it much less rare than is generally supposed. My observations at the bed-side, and my researches in pathological anatomy, are quite favourable to the latter opinion.

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* Auscultation mediate, edit. de 1837, notes des pages 350, 353.

† Clinique medicale de la Pitie, année 1836.

‡ Dict. de Medecine, en 21 vol. t. 17, p. 227.

1°. As anatomical characters, I would refer to the chronic indurations of the pulmonary tissue with considerable increase of its density and resistance, *fawn-coloured*, *greyish*, or of a *dirty white*, which we find in one or more lobules, or perhaps in a considerable part of a lobe, especially in the summits; I would refer also to that chronic induration, *of a deep red colour*, with increased resistance of the tissue of the lung, a kind of carnification of it; I would lastly refer, with M. Andral, to those *blackish* indurations, called *melanosis*, and which, like the preceding, are chiefly met in persons who have been subject to chest affections.

As symptoms I would mention the following: 1°. Diminution of inspiration, more marked in proportion as the induration is more complete, more extensive, and as it occupies more uniformly the mass of the pulmonary tissue where it is situated: this diminution of inspiration sometimes descends as low as 1 or 2. Augmentation of expiration, more marked in proportion as this densification is more complete, more extensive and less uniform; that is, the inspiratory murmur is less diminished, the expiratory more increased, in proportion as there are more lobules of healthy tissue in the midst of the diseased ones; and *vice versa*. The expiratory murmur even suffers a marked diminution both in duration and intensity when the induration occupies uniformly the entire thickness of a lobe of the lung.

2°. Alterations of *quality*, more marked in expiration than in inspiration, proportional in degree to the degree and uniformity of the pulmonary induration; slight, sometimes even inappreciable, when many sound lobules are enclosed among the affected ones; these alterations of *quality* are always proportionally less considerable than in acute pneumonia.

3°. Character of hardness, of dryness, of great difficulty of production in the respiratory murmurs, a character which is very distinct, especially when no alteration of *quality* has yet taken place.

4°. Distinct bronchophony.

5°. Bronchial cough.

6°. Sounds of the heart more distinctly heard at the place where the preceding signs are observed.

7°. More or less diminution of the sound on percussion.

8°. Diminution of the vibration of the voice.

9°. When chronic pneumonia exists at the top of the lung, and occupies so much of it as to have produced sensible atrophy of that part of the organ, there may be a diminution of the volume of the corresponding top of the chest, a diminution of the partial movements of this side, and sinking in of the spaces above and below the clavicle.

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* Auscult. Med. ed. 1837, vol. 1, p. 586.

Sometimes chronic bronchitis and a habitual cough, a feeling of uneasiness, of stuffing, of obstruction within the chest, coexist with the preceding signs. As far as I have observed, there rarely exists any obvious deterioration of the patient's health ; more rarely still do we see symptoms of hectic fever, if the chronic pneumonia, such as I have above described it, in its three principal anatomic forms, be perfectly free from complication with tubercles or any other affection. (31)

§ VII. CHRONIC INDURATIONS OF THE LUNG.

All that I have just said on the symptomatology of chronic pneumonia is perfectly applicable to every pulmonary induration, whatever be its nature, which presents pretty nearly the same anatomical conditions. The signs I have pointed out being physical signs, it is obvious that they must be nearly similar; such is in fact the result of clinical observation. It is only certain forms of these organic alterations, such as tubercular infiltration, and certain modifications of the primary physical conditions resulting from the progress of the malady, that can produce variations of the symptoms : such are, in phthisis, the pulmonary crumpling sound, the dry and humid crackling ronchi, the cavernulous and gurgling ronchi, the cavernous and amphoric respiration.

So too the decline of the patient, the existence or non-existence of the symptoms of hectic fever, the degree and progress of these symptoms do not depend upon the form, upon the extent of the foreign body deposited in the lung, upon the physical fact, but upon the nature of the alteration which constitutes this physical fact, and the organic dispositions in which it finds the patient.

§ VIII. PHTHISIS PULMONALIS.

The signs of the 2nd and 3rd stages of phthisis are so well known that I will not stop to notice them. Hereafter I will enter into a detailed account of every thing that may serve to determine the first stage (see 2nd part and especially chap. vi.). For the present I will only give a succinct summary of the signs furnished by auscultation, percussion, touch, inspection, and the morbid sensations of the patient, in establishing the connexion between this first stage and the succeeding ones.

1°. Diminution of the duration and intensity, but especially of the duration of the inspiratory murmur, which may fall to 4 and even 2.

2°. Augmentation of the intensity and duration of the expiratory murmur, which may rise even to 20.

3°. Rough, hard, dry, difficult character in the murmurs, but especially in the inspiratory.

4°. Alterations of *quality*, appearing first in expiration, spreading afterwards to inspiration, preserving greater intensity in the former, and passing successively through all the alterations of *quality,* from the clear to the amphoric character.

5°. Pulmonary crumpling murmur or ronchus, coexisting almost exclusively with inspiration.

6°. Dry crackling ronchus, coexisting almost exclusively with inspiration, and passing successively into the humid crackling, the cavernulous, and cavernous ronchi, which occupy more and more equally both inspiration and expiration.

7°. Bronchophony more or less intense.

8°. Bronchial cough more or less marked.

9°. Transmission of the sounds of the heart through the tuberculated part of the lung.

10°. Sound on percussion over this part more obscure. Feeling of greater resistance to the finger; sometimes even complete dullness on percussion.

11°. Diminution of the vocal vibration.

12°. Diminution of the partial movements of the upper parts of the chest; diminution of their volume; sinking in of the spaces above and below the clavicle.

In general these different symptoms express by their degree, the different and successive degrees through which the tubercular infiltration and the process of softening pass. They are usually more marked on one side than the other, have their special seat in the superior parts of the chest, and more peculiarly in the subclavicular regions.

13°. Feeling within the chest of restraint, of difficulty in respiring, of annoyance from speaking or coughing, sometimes even of pricking or shooting pains. These morbid sensations are usually more marked on one side of the chest, where the tuberculization is more advanced.

For the other symptoms, their different combinations, &c. see hereafter my special researches on the diagnosis of the first stage of phthisis (2nd part).

§ IX. GANGRENE OF THE LUNG.

Amongst the cases of gangrene of the lung that I have observed, I find only one that includes a sufficiently detailed account of the auscultatory signs, from the appearance of the gangrene to its resolution, and during its entire duration. The following are the symptoms observed in this case*.

1°. Some days previous to the manifestation of the gangrenous odour in the sputa and of the general symptoms of gangrene, we recognized all the symptoms of active sanguineous congestion in its most intense form. These symptoms existed in the middle third of the posterior part of the right lung. Some traces of sonorous and sibilant ronchi were combined with them.

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* *No. 5, St. Michael's* Ward, care of M. Andral, hospital de la Pitie, 1836.

2°. Afterwards, when the general symptoms of gangrene and the gangrenous odour of the expectoration appeared, the signs of congestion extended far beyond their former limits, and at the same time we observed that in the place where they had appeared, and where they always maintained their maximum intensity, the viscid humid character greatly increased, the bubbles of the congestive ronchus became larger, more humid and more numerous, bronchophony was here more distinct, while sonorous and sibilant, mixed with mucous ronchi, were audible in the same side of the chest, in front, and scarcely at all in the opposite side. As long as the gangrenous odour of the sputa, which was intense, continued, as long as the brownish red colour of the expectoration and the general state of the patient favoured the opinion of the continuance of the gangrene, the symptoms remained nearly the same; they were only a little more or a little less distinct; at length the signs of gangrene disappeared, and with them, slowly, gradually, all the local phenomena. These followed in their disappearance the same course as in the termination by resolution of active sanguineous congestion of the lungs.

ARTICLE III.

NERVOUS DISORDERS OF THE RESPIRATORY ORGANS.

Under this title I include that rather numerous class of cases in which we observe more or less disturbance of the respiratory murmurs and movements, without any structural lesion whatever of the respiratory organs that we can connect with this functional disorder. I will not here enter at all into the consideration of the causes that produce these disorders, or of the intimate nature of these maladies. Whether they depend on a greater want of hæmatosis at certain times; on a peculiar excitation of the nervous system of the lung; on the irritation of this organ by blood more or less rich than ordinary, or modified in some of its elements; on spasm of the muscular fibres of the bronchial system; on a peculiar expansive and contractile power in the air cells; on a convulsive state of the muscles of the glottis, or of those of the chest; on a sort of influence of irritation, &c.*; whether they depend on one or other of the preceding causes, is of little importance in the question I am considering, and perhaps also in practice, which derives but little advantage from all these purely theoretical considerations. With a view to the subject of auscultation, all these affections are divisable into two classes: 1°. The effect of one class is to diminish the respiratory murmurs; 2°. that of the other is to increase them. These two classes correspond, the second to *the asthma with puerile respiration*, and the first to the *spasmodic asthma* of Laennec. The first gives rise to by far the most alarming train of symptoms, and sometimes places the patient in imminent danger of asphyxia; whilst the second only produces respiratory movements much deeper, more frequent, irregular, and rendered painful by the continual effort with which they are accompanied.

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* The reader will find all these opinions scattered through different works, and nearly all brought together in the edition of Laennec by M. Andral, 2nd vol. p. 365 to 400.

I. In the first case, the respiratory motions have the character which has been designated convulsive. The murmurs and the movements are in an inverse ratio to each other. The latter are produced by a very powerful effort, and the former are scarcely audible; they are even in general less perceptible, in proportion as the thoracic movements are more convulsive and more energetic. There is also an alteration of the rhythm of the murmurs as of the movements: the murmur is sometimes suddenly arrested in its course. But the most common auscultatory character of this kind of affection is the great diminution or even complete cessation of both respiratory murmurs; sometimes we see them separate from each other, and the inspiratory alone or the expiratory alone cease to exist, while the other continues unchanged, or is even exaggerated. In the latter case it is generally the inspiratory murmur that is diminished, while the expiratory is natural or increased. The jirking character of the respiratory murmurs belongs also peculiarly to this first class of nervous disorders of the respiratory organs.

II. In the second class there is merely exaggeration of the respiratory murmurs. Inspiration and expiration still more are greatly augmented in duration and intensity. But this exaggeration is not regular and uniform, as in supplementary respiration; on the contrary, it is characterized by irregularity, differing from itself each moment, and sometimes alternating with diminution. Thus these two classes of disease are not separated by any difference in their nature that must always keep them isolated from each other. Their effects alone differ, their nature is the same: it is the same cause that acts in each case; but this cause, which consists in a disturbance of the nervous system, acts sometimes in one direction and sometimes in another; sometimes through its agency, the air penetrates the respiratory system with more force and frequency; sometimes, on the other hand, it is only admitted with difficulty, very imperfectly or is even completely excluded; but in either case it stamps its peculiar character of disorder and irregularity both on the respiratory movements and murmurs.

ARTICLE IV.

DISEASES OF THE PLEURA.

All the affections of the pleura that are capable of producing auscultatory phenomena, may be included in the history of pleurisy and pneu*mothorax*.

§ I. PLEURISY.

Considered with a view to the phenomena furnished by auscultation, pleurisy may be divided into 4 principal forms: 1°. dry pleurisy; 2°. pleurisy with recent pseudo-membranous secretion; 3°. pleurisy with liquid effusion; 4°. pleurisy with old false membranes surrounding the lung.

I. *Dry pleurisy.*—We sometimes find, in persons who have sunk rapidly under acute diseases, the pleura, the pericardium, the arachnoid, or even the peritoneum, quite dry in parts, sometimes over a large extent of surface, sometimes here and there in scattered spots. It is the same dry and somewhat withered aspect which these membranes present when they have been exposed for a short time to hot air. Instead of the smooth, polished surface, soft and somewhat moist to the touch, that characterizes them in their normal state, they are dull and lustreless, dry and rather hard. A slight pseudo-membranous deposit of an opaline hue, which we sometimes find on other parts of the same serous surfaces, and the symptoms of pleurisy, of peritonitis, &c. that existed during life, usually prove the nature of this alteration. This slight dryness of the serous surfaces may, however, exist alone and independently of the pseudo-membranous deposite that sometimes accompanies it. I have had opportunities of examining persons who died during the height of an attack of acute articular rheumatism, and of observing the same anatomical fact with respect to the serous membranes of some of their joints. Experiments made on animals give the same result. In short every thing authorizes the opinion: that this peculiar alteration of the articular and visceral serous surfaces is one of the forms of inflammation. The conditions under which the autopsies, that I rely on, were made, and many other circumstances which I think it useless to mention, are inconsistent with the opinion, that this alteration is a mere cadaveric effect: the symptoms observed during life would in themselves be sufficient to make us reject it.

In cases of pleurisy of this kind, I have recognized, by auscultation, at the parts of the chest where the pleura was subsequently found as I have described it, 1°. a very slight, superficial sound, like that produced by passing the finger more or less forcibly over a dry and smooth surface, or rather by making two thin leaves of paper glide upon each other. M. Reynaud was the first to point out this form of pleurisy, and he has described this slight sound by the name of *grazing* (frôlement). 2°. The respiratory murmurs suffer, in dry pleurisy, no diminution from their normal standard*, no change of the characters that constitute their nature. They are the same as usual; the only morbid character they present, is the friction sound, which in general coexists with inspiration only.

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* We must except cases where there is pain of the side. In these cases there is diminution of the inspiratory murmur, but this diminution depends on nervous influence, and not on a physical obstacle to the dilatation of the lung.

II. *Pleurisy with pseudo-membranous deposites.*—If inflammation of the pleura has produced a pseudo-membranous layer of no great thickness on its surface, we find at the part occupied by this, slight diminution of the intensity and duration of the inspiratory murmur, which sinks to 6 or 8; and on the contrary, slight augmentation of the expiratory, which may be represented by 5 or 6.

But if the layer becomes thicker, we find the inspiration continue to decrease, the expiration return to its normal limits, then decrease in its turn, but only follow at a distance the diminution of the inspiration.

Some slight pleuritic friction sound is frequently combined with the preceding signs. In this form and in its simple state, pleurisy is not usually accompanied by any trace of alteration of *quality.*

I have ascertained by autopsy that even a recent false membrane, a line in thickness, is often sufficient to produce distinct dullness on percussion.

In the same anatomical circumstances, we sometimes find also a little less vocal vibration of the thoracic walls at the parts where the false membranes exist.

In the cases I have been supposing, the normal volume of the lung is unchanged; it touches the walls of the thorax with its entire surface; for it is only after effusion into the pleura that we find the lung bound down into a smaller compass than natural by the false membranes deposited on its surface.

III. *Pleurisy with effusion.*—In this case the signs vary with the quantity of the effusion.

1°. If the effusion be extremely small, it generally occupies the space between the base of the lung and the diaphragm, and then it seldom happens that any local sign reveals its existence. Auscultation and percussion have given me the same negative result in cases where the effusion was considerable, but confined between the lung and the diaphragm in a kind of pouch, formed by adhesions that arose from the circumference of the base of the lung. It is on the right side especially, on account of the vicinity of the liver, that we are liable to err in such a case.

2°. When the effusion is extended in a sheet over the lung, and is at the same time not considerable, the only signs usually observed are, more or less diminution of the murmurs, and especially of the inspiratory; more or less obscurity of the sound on percussion, some diminution of the vocal vibration, a change in the resonance of the voice almost inappreciable, and without any well determined character. These signs decrease gradually, in proportion as we ascend from the inferior parts; it is only when the effusion is considerable, that they cease abruptly at a certain point, and that the effused fluid has a level.

3°. When the pleuritic effusion is more abundant, we find along with the preceding characters, which are then also more marked, alterations of *quality* successively more elevated, and whose degree represents in general very accurately that of the effusion; this, however, only within certain limits, for the bronchial character disappears if the effusion become very copious. These alterations of *quality* become sensible, from the moment the layer of liquid is sufficiently thick to produce sensible compression of the surface of the lung. They appear first in expiration, afterwards extend to inspiration, and tend more and more to affect each equally, in proportion as the effusion augments: at the same time they seldom rise above the second degree of bronchial character. When the effusion has increased beyond the limit at which it can produce the bronchial character, we see the latter, during its decrease, follow in the opposite direction the same track it traversed in its increase; but, in this particular case, its decrease is usually very rapid. Egophony may be heard at the same time as the bronchial character; but this sign is infinitely more rare, more inconstant, more deceptive than the alterations of *quality*. When egophony does not exist, it is usually replaced by a kind of bronchophony. (See at page 84 what I have said of egophony.)

4°. As the effusion increases then, we find the sound on percussion, the vocal vibration recognized by the hand, the partial movements of the thoracic walls, and the two respiratory murmurs gradually decrease; if it becomes very abundant, the dullness on percussion is complete, the vocal vibration entirely destroyed, the thoracic movements almost extinct, the thoracic cavity enlarged, the bronchial character disappears, the reverberation of the voice presents the characters described at page 86, and the respiratory murmurs are totally inaudible. Thus all is negative in the symptomatology. It should be remarked that the diminution of inspiration and expiration is governed by this law; that this diminution is always more considerable and more rapid in inspiration than expiration; that the inspiratory murmur has disappeared entirely, while that of expiration still exists. It results from this, that the complete and constant disappearance of the expiratory murmur ought always be considered as a certain sign of a *very abundant* effusion. I have already said that in inconsiderable effusions, when inspiration had sunk so as to be reduced to 6 or 8, expiration was a little augmented. These are, usually, the signs of an effusion which is just commencing; but we must take care not to confound with simple augmentation of the expiratory murmur, the prolongation of its duration occasioned by the coexistence of the bronchial character; the mistake is easily made by those who are not practised in the appreciation of the normal expiratory murmur, and it leads one to suppose the presence of a much greater effusion than really exists; it may be avoided by paying attention to the *quality* of the sound.

I will mention a fact in support of the different propositions I have just stated. We had in March 1838, at No. 29, St. Louis's Ward, (hospital of La Charite, under M. Andral) a man in the vigour of life, in whom there existed a pleuritic effusion in the right side of the chest, so considerable, that this side was dilated nearly two inches. In front there was diminution of the intensity and duration of inspiration, which at the base of the chest amounted to complete cessation. The expiratory murmur was increased at the top of the lung, without exhibiting any alteration of *quality ;* a little lower down this sound resumed its normal degree, then it fell below this, and thus it successively diminished from above downwards, and disappeared entirely towards the base, but below the point at which the inspiratory murmur ceased to be audible. The same characters existed behind, appearing in the same order, but more rapid in their succession. No alteration of *quality* existed either before or behind.

5°. M. Hirtz* has truly observed that a change in the relation of the lung with the effused fluid may determine such a change in the symptoms, that we might be induced to think the effusion had diminished while in reality it had increased : I cannot, however, view this change of relation in any other light than as an accidental occurrence, and not exactly a general rule, not a constant result of the natural progress of the affection; such at least is the inference I draw from my own researches, undertaken with nearly the same object and the same results. M. Hirtz has however put the matter very well: suppose the effusion moderate, 1°. the lung floats in the effused liquid; this liquid forms a layer, more or less thick, round the organ; dullness on percussion extends to a great height; the respiratory murmurs are diminished to the same extent; the bronchial character and egophony may be also recognized in the same parts; 2°. the effusion is partly absorbed; the preceding signs have disappeared at a certain height, but we still find them at the inferior parts; 3°. the effusion augments, and at the same time it happens that the lung, instead of being surrounded by the effused liquid, rises above it, and comes into contact with the walls of the chest; the chest has resumed its clearness, and the respiratory murmurs their intensity, in places where they were greatly diminished; the bronchial character and egophony are no longer audible in any part, not even below, because the effusion is in fact too abundant to allow of the production of those signs; one might be tempted to attribute this change in the symptoms to a diminution of the effusion, though this has in reality increased. The continuance of the bronchial character and of egophony at the inferior part is evidence of a real diminution of the effusion; their disappearance, on the contrary, indicates that this diminution is only apparent, that the change I have just described has occurred in the relation of the lung with the effused fluid; but to enable us to come to this conclusion, the resonance of the chest and the respiratory murmurs must have reappeared in the superior parts, and the bronchial character have at the same time disappeared.

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* Recherches sur quelques points du diagnostic de la pleurésie, par M. Mathieu *Hirtz, archives médicales*, Fevrier 1837, p. 172.

6°. In ordinary pleuritic effusion, the local symptoms vary with the position of the patient ; in simple pseudo-membranous pleurisy they remain fixed, however the position may be changed.

7°. During the resolution of a pleuritic effusion, the alterations of the respiratory murmurs in intensity, in duration, and in *quality*, follow in their disappearance the same course in the opposite direction, that they followed in their appearance and increase.

IV. *Pleurisy of long standing with thick and hard false membranes round the lung.*

1°. Diminution of the respiratory murmurs proceeding sometimes to absolute cessation.

2°. Alterations of *quality*, in cases only where the lung is bound down in a much smaller space than natural by the membrane that envelopes it, or where a partial false membrane has acquired considerable thickness and great density.

3°. Dullness on percussion sometimes very considerable.

4°. Almost complete extinction of the vibration of the voice and of the partial movements of the walls of the chest.

In a patient that died in 1836 at La Pitie (ward Saint Leon, No. 19), we found on one lung a partial false membrane nearly an inch thick in some points, and yet there was no trace of the bronchial character during life. There may be therefore exceptions to the proposition I have laid down.

§ II. PNEUMOTHORAX.

Remarkable diminution or complete absence of the respiratory murmurs, according to the degree of pneumothorax. Sound tympanitic ; considerable diminution of the vibration of the voice ; diminution of the normal resonance of the voice, and very considerable diminution of the partial movements of the chest.

§ III. SIMPLE HYDROPNEUMOTHORAX.

Signs of pleuritic effusion in the depending parts of the chest. Signs of pneumothorax in the superior parts.

§ IV. HYDROPNEUMOTHORAX COMPLICATED WITH PERFORATION OF THE LUNG.

In the upper parts of the chest: 1°. very considerable diminution or absence of the normal respiratory murmurs; 2°. amphoric character, coexisting with both periods of respiration, but especially with the second; 3°. metallic resonance coexisting chiefly with expiration;

4°. metallic tinkling produced chiefly in expiration; 5°. sound on percussion tympanitic; 6°. considerable diminution of the vocal resonance; 7°. considerable diminution of the partial movements of the chest; 8°. considerable diminution of the vocal vibration.

In the inferior parts: Signs of pleuritic effusion. (32)

ARTICLE V.

DISEASES OF THE PARIETES OF THE CHEST.

Pleurodynia.—I have noticed (p. 51) the auscultatory phenomena observed in cases of pleurodynia, and the differences between these and the phenomena of commencing pleurisy that can be of use in the differential diagnosis of these two affections. It will be seen from the exposition I have given of the morbid characters of the respiratory murmurs in pleurisy and pleurodynia, that M. Andral* is right in saying that there is diminution of the inspiratory murmur *in dry pleurisy with pain in the side;* but that Laennec† was also right in objecting that this cannot be regarded as a differential sign between pleurisy and pleurodynia: not only is this character insufficient for this differential diagnosis, but it cannot be of any use, inasmuch as it is common to the two affections.

ARTICLE VI.

DISEASES OF THE LARYNX.

Auscultation at a distance of the inspiratory and expiratory sounds furnishes valuable signs in the diagnosis of diseases of the larynx. Attempts have been made to apply the direct or mediate auscultation of this organ to the same object. I shall notice only the latter here.

In 1836, M. Lombard of Geneva, to whom science is indebted for some valuable works, when visiting M. Andral's wards where I was an intern, told me that he could, by mediate auscultation of the larynx, determine the maximum seat and frequently the anatomical forms of most of the alterations of this organ. This astonished me, for my own researches on the subject, which were tolerably extensive, had only given me negative results. M. Lombard had the politeness to make an application of his principles in the case of one of our patients in the last stage of phthisis. I avow I was unable to detect the differences that he indicated between the two sides of the larynx; and several persons, practised in auscultation, were likewise unable to perceive any difference between the sounds heard on the right and left sides of the organ. Since that time I have repeated my researches on this subject, and I have come to the conclusion that *mediate* auscultation of the larynx cannot furnish any sign capable of enabling us to recognize with precision, in the generality of diseases of the larynx, either the exact part of the interior of the organ, at which the disease is situate, nor at which side it has attained its maximum of developement, still less the peculiar nature of the affection. Other observers well skilled in clinical investigations have not been more successful. The mere consideration of the different anatomical conditions of the diseases of the larynx, leads indeed to this conclusion: that these diseases cannot produce such constant and marked modifications of the respiratory sounds, as would render these sounds faithful interpreters of these alterations. (33)

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* *Auscultation médiate*, edit. de 1837, t. 2, page 411; note de M. Andral.

† *Ibid. note* de Laennec. Forbes's translation, page 432.

The results contained in the six preceding chapters have been derived from the analysis of a very great number of cases. The limits of this volume not permitting me to introduce in their support even a part of those cases, I appeal for these results to their natural judge, clinical observation. At the same time, the disease I have described by the name of *active sanguineous congestion of the lungs* being as yet very little known and apparently not very common, I thought it right to give the two following examples of it.

First Case.........A hair-dresser, 17 years of age, of a tolerable constitution, and a mixed lymphatico-sanguine temperament, was admitted into la Pitie, 27th April, 1836, under M. Andral. For three weeks he had been every day attacked with languor, lassitude, and rigors followed by heat and sweating. To this febrile state were alternately superadded, sometimes all the signs of cerebral congestion (1st form of M. Andral), great sensibility to light, tingling in the ears, dizziness, vertigo; sometimes much oppression, feeling of stuffing in chest, and a whitish, somewhat viscid expectoration; sometimes pricking pains in the throat, impaired digestion, and constipation.

The day after he was admitted, April 28th, the brain and digestive system appeared unaffected, but it was otherwise with respect to the chest; at the right side posteriorly, the inspiratory murmur was much diminished in duration and intensity; the expiratory presenting nearly its normal duration and intensity; and both exhibiting the humid character in a marked degree. Coexisting with inspiration only, a ronchus, the bubbles of which were small, humid, tolerably regular, not attaining their complete developement, and exhibiting in their succession a sort of continuity which formed a contrast to the usual roundness and isolation of the bubbles of the other ronchi. No trace of alteration of *quality* in the respiratory murmurs. Resonance of the voice normal; sound on percussion normal also. In every other part of the chest the respiratory sounds were pure. Expectoration rather copious, white, a little viscid at bottom of vessel, frothy at top. No cough, no stitch in the side; but a feeling of difficulty of breathing and of stuffing through the entire chest (Demulcents and mustard foot baths).

The signs of cerebral congestion began to reappear in the course of this day, the 28th; the following morning they were strongly marked. On examining the chest, we were astonished not to find in any part of it the slightest trace of the local signs we had observed there the day before; the respiration was every where pure and expansive. The feeling of oppression and stuffing had also disappeared. (Same treatment.)

1st. May. The symptoms of affection of the head had diminished, and we again found in the right side of the chest posteriorly the same signs as before, but much less marked. Respirations 26, pulse 68. (Blood-letting—low diet.)

May 2nd. The only morbid phenomenon found in the chest, was a trace of the humid character in the respiratory murmurs. But the symptoms of cerebral congestion were much more marked, and the patient's face was much more flushed. (Bleeding again.)

The following days there was a marked improvement as regarded the head.

The 5th of May, all the cerebral symptoms had disappeared; while we found again the same signs in the same part of the chest, but in a less degree. The feeling of oppression, of stuffing, had returned with them.

The 6th of May, in the morning, all was changed; the latter phenomena had disappeared, the respiration was pure and easy, and the patient complained of heaviness of the head, great sensibility to light, and constant giddiness. He was bled a third time. This was the first time we remarked the characters of the blood; the clot occupied the whole diameter of the vessel, was red on the surface, resistant, without a trace of crust, and surrounded by a little serosity. The 7th of May, and the following days, the symptoms of cerebral congestion disappeared, and the respiration continued pure and easy.

On the morning of the 11th, the patient who was naturally civil, gentle, and lively, was on the contrary extremely petulant, impatient, and melancholy, without the slightest obvious cause. The countenance was animated, the gums injected, and the state of cerebral excitation was manifested in his look, in the general expression of his countenance, and in his movements. The skin was warm, the pulse full and developed. The chest was not examined this day, but it was the next, and the absence of all morbid phenomena there ascertained. Blood drawn again this day, presented no trace of crust. The 13th of May, pulse 104; skin moist; respiration 20, natural; no motion from bowels for six days; considerable decrease of the affection of the head.

The 22nd a new bleeding was required; the blood presented the same characters as before. This bleeding was rendered necessary by the return of the symptoms of cerebral congestion. The morbid phenomena of respiration had not reappeared.

The 24th the patient was dismissed from the hospital for misconduct.

Second Case.—A man, aged 34, of a remarkably strong constitution, large chested, and of a well marked sanguine temperament, lay at No. 23 ward of St. Leon, hospital of la Pitie, under the care of M. Andral, 18th January, 1836. He had, he said, two attacks on the chest already, one at the right, the other at the left side; one 2 years, the other 28 years before. Almost every winter he caught cold, and had a cough for a considerable time after. In other respects he got good health. Eleven days before he came into hospital he had been seized with feverish symptoms, pains in the back, and difficulty of breathing, which had soon obliged him to give up working.

The day after he came in, January 19th, we recognized the following symptoms: strongly marked general sanguineous plethora; skin hot; pulse frequent; very severe headache; dry, harassing cough; expectoration tolerably copious, mucous, rather thick, containing some streaks of pure blood; respiration frequent; sense of stuffing in the chest; no pain in the side. Anteriorly and posteriorly in the base of each lung, but especially of the left, we found on auscultation: 1°. the inspiratory murmur diminished in duration and intensity (5 instead of 10); 2°. marked humid character in both respiratory murmurs; 3°. during each inspiration a peculiar ronchus, not resembling any of those described by Laennec, its bubbles fine and humid, slowly developed in succession, not perfectly rounded, succeeding each other before their perfect developement, and thus appearing to be continuous. A little dullness on percussion at the base of both lungs. Vocal resonance normal; vocal vibration also normal. (Blood-letting; pectoral mixture.) While the blood was flowing, the patient said he felt his chest relieved, his breathing become free, and the feeling of stuffing disappear. An hour and a-half after the bleeding I examined the patient again, and was astonished to find that all the above local signs had disappeared on both sides of the chest in front, and were considerably diminished behind; the general state of plethora was also much less. He passed a good night, and the next day, 20th January, appeared quite easy; his complexion was natural; cough less frequent and less fatiguing; expectoration viscid, but quite white. Respiration still somewhat incomplete and a little humid, was the only morbid phenomenon observed on auscultation. A very slight inflammatory pellicle was barely discernible on the large firm clot formed by the blood. (Blood-letting again.) From this time the general and local state of the patient continued to improve, slowly it is true, but steadily. The local phenomena observed in the chest completely disappeared, at the right side first, and then at the left. The feeling of stuffing and oppression ceased with the other local signs. A dry cough remained for some days, and was the latest symptom. Respiration, which on the 20th January was 32, fell by degrees to 28, to 24, and lower; the pulse fell in like manner; and the patient left the hospital, February 8th, perfectly recovered.

It seems to me useless to comment on these cases, after what I have said of active sanguineous pulmonary congestion. Every one can examine and decide on them for himself.

CHAPTER VII.

OF THE PRIMARY SEAT OR PLACE OF ORIGIN OF THE PHYSIOLOGICAL AND MORBID SONOROUS PHENOMENA OF THE RESPIRATORY APPARATUS.

Laennec admits without hesitation, without even stopping to enquire whether there could be a second opinion on the subject, that the vesicular respiratory murmur is produced in the air cells, that it results from the passage of the air into the small bronchial divisions, and is independent of the sounds that occur in the pharynx. He in like manner refers the bronchial, tracheal, pharyngeal, buccal, nasal, cavernous sounds to the natural or artificial cavities from which they derive their names.

This theory was so simple, so natural, so much in accordance with facts, that it was adopted by all. No one even thought of questioning its accuracy.

In 1827, M. Chomel* first suggested that the bronchial breathing of pleurisy might be nothing more than the reverberation in the pulmonary tissue of a sound generated in the larynx and back of the mouth.

In 1834, M. Beau† extended to all the respiratory sounds, physiological and morbid, the idea that M. Chomel had applied to one only. He concluded from some experiments he made: "that the different respiratory sounds are not the mechanical result of the passage and friction of the air against the walls of the bronchial ramifications where they are heard, but are produced by the reverberation, through the whole column of inspired or expired air, of the sound resulting from the impulse of this column against the veil of the palate or the adjacent parts."

This theory of M. Beau found no supporters, or if it were at first adopted by some, seduced by the ingenious manner in which the author presented it, they soon renounced it again, and returned altogether to the notions of Laennec. The great majority of persons devoted to clinical studies now admit, with the illustrious discoverer of auscultation, that the air, in passing and repassing through the different sections of the respiratory apparatus, produces in each of them a peculiar sound, which derives its special character from the texture of each of those parts, which results from the action of the column of inspired and expired air upon the walls of these cavities, and which is entirely independent of the sound produced in the neighbouring sections. This is the opinion we adopt, as we have already stated in chapters I. and II.

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* Dict. de Med. en 21 vol. t. 17, p. 133.

† Recherches sur la cause des bruits respiratoires perçus au moyen de l'auscultation, *Paris, 10 Juin, 1834*; p. 15.

Although the theory of M. Beau scarcely belongs to science except historically, it is necessary however that we stop for a moment to refute it, on account of some erroneous facts to which it has given currency.

Let us in the first place establish this : that the bronchial and vesicular sound may very well be produced by the action of the column of air in inspiration and expiration upon the walls of the bronchi and air cells. This mechanism of production is quite in accordance with the laws of physics. We can produce at pleasure the bronchial sound by blowing into any ordinary tube, or into the bronchial tubes separated from the pulmonary tissue, or indeed by blowing into those tubes after having converted the lung into a solid mass by injecting it with suet. Neither can there be any doubt as to the seat of the vesicular murmurs : my experiments with sponge clearly prove this (see introduction, p. 16); there is in this case no possible source of sound except the penetration of air into the cells of the sponge and the action of this air upon their walls. Whether the sound depends on friction or merely on the alternate expansion and contraction of the sides of the cells, is of little importance : I only maintain that the sound is produced in the cells themselves.

The possibility of the origin of the respiratory sounds in the bronchi and air cells being placed beyond all doubt, we will now proceed to prove it directly.

Two adults on whom I performed the operation of tracheotomy, one at the Hotel Dieu, in 1835, the other at la Pitie in 1836, afforded me an opportunity of making some observations, and some conclusive experiments on this point. Both were affected with considerable contraction of the larynx, depending on a different cause in each. Before the operation, the laryngeal inspiratory and expiratory sounds were alone heard throughout the whole extent of the chest. There was no trace of the natural respiratory murmurs. The patients were in a state of impending asphyxia. After the operation, a canula being introduced into the trachea through the wound in the neck, the laryngeal sound ceased entirely and was replaced by the sound of the canula, a sound of a clear metallic quality, almost bronchial, coexisting chiefly with expiration. Like the laryngeal sound it was heard at a distance, and by mediate or direct auscultation ; but besides the sound of the canula, the ear applied to the chest was very sensible of another sound, which it distinctly recognized as the inspiratory and expiratory vesicular murmur that had begun to reappear. It was easy to distinguish these two kinds of sounds : we felt distinctly, in listening to the sounds called vesicular, that they originated in a part of the pulmonary organ immediately beneath the ear ; that the air which produced them played in cavities of very small diameter ; whilst the sounds of the larynx or of the canula came from a distant part, and were produced by the passage of air through a large tube. The sound of the canula remaining always the same, we found the inspiratory and expiratory murmurs become developed in proportion as the patient improved ; and yet respiration no longer took place through the superior respiratory passages, for we took care in these experiments to make the patients respire through the canula exclusively. When, by closing the canula, we compelled the patient to respire by the superior passages, the sound of the canula was replaced by that of laryngeal respiration; but this sound, much less strong than before the operation, no longer prevented us from hearing the vesicular murmurs. Still later the state of the larynx being ameliorated, the laryngeal sound diminished, and we heard at times by immediate auscultation a different sound, more clear, more metallic, which was produced particularly in certain states of the opening of the mouth, and which was readily distinguished as coming from a distance and from above; it was the pharyngeal sound. We were able in the same way to make the patient produce the sounds of nasal and buccal respiration; and all these accessory, variable, inconstant sounds did not prevent our hearing and distinguishing accurately the vesicular murmurs of inspiration and expiration, which were constant, whatever might be the changes produced in the preceding sounds. When the canula was removed, and respiration was effected through the fistulous opening exclusively, a new variety of metallic sound was heard on auscultation, along with the vesicular murmurs; but the latter preserved always the same characters.

When we made one of these patients breathe in our manometric apparatus, we found the vesicular murmurs diminish and disappear in proportion as, from the diminution of air in the apparatus, a smaller quantity passed into the cells of the lungs.

A pleuritic effusion occurred in the patient operated on at la Pitie, at the time she was still breathing through the canula: the vesicular murmurs gradually disappeared in the side occupied by the effusion, and were replaced by bronchial respiration quite pure; on the opposite side they assumed the puerile character. This was the case in whatever way we made the patient respire. By degrees the effusion was absorbed, the bronchial character disappeared, and the vesicular murmurs gradually reappeared: the result was the same in whatever way we varied the respiration of the patient. Still later the laryngeal affection, which had existed more than 4 years, was completely cured, and she returned, as regards the results furnished by the auscultation of the vesicular and pharyngeal sounds, into the condition common to all healthy persons. These conditions are, in short: that two classes of sounds may be heard by the ear applied to the chest; one constant, apparently produced immediately beneath the ear, and varying in duration and intensity according to the force and duration with which the air penetrates into the divisions of the bronchi; these are the vesicular murmurs of inspiration and expiration; the others inconstant, depending on the mode in which the individual makes the air pass through the superior respiratory passages, varying in their intonation according as the respiration is more or less *buccal, nasal,* pharyngeal or laryngeal, replacing each other every moment, having all a metallic *quality*, and leaving on the ear the impression of an origin more remote in proportion as their *quality* is more clear; these are the sounds called buccal, pharyngeal, &c. We distinguish these two classes of sounds from each other as easily in any healthy person, as in the tracheotomised patient whose case I have just detailed: they are altogether independent of each other. There exists between them no connection of cause and effect. We have a plain proof of this in what occurs when the bronchus of a lobe or of an entire lung is obliterated: the vesicular murmurs are no longer heard in the portion of the organ to which this bronchus is distributed, and yet the guttural respiration, whose conditions of production have not changed, is distinctly audible, even in the part where no trace of the vesicular murmurs exists. It is the same in those cases where a thick false membrane enveloping the lung prevents its vesicular expansion: there is no bronchial respiration, and the only sound heard is that of pharyngeal respiration.

The patient on whom I operated at *la Pitie* had no soft palate; it was completely destroyed. In her, however, as I have said, the vesicular murmurs were heard distinctly; a new proof that they are not produced by the reverberation of the impulse of the column of air against the soft palate. Moreover in this case the guttural sound was heard distinctly, a proof that this sound does not depend merely on the impulse of the column of air against the anterior and posterior walls of the soft palate *, but chiefly on the action of these columns against the walls of the pharynx. The nasal and buccal sounds of respiration have the greatest analogy with the pharyngeal or guttural, and yet nothing similar to the soft palate exists in those cavities.

M. Beau states in proof of his theory, that if we suspend the guttural sound during one of the respiratory periods, or during both, the corresponding vesicular murmur, or both vesicular murmurs disappear. The reason is, that in these cases there is complete cessation of the penetration of air into the respiratory passages, and disappearance of the two classes of sounds by this common cause; we will be convinced of this by reading the account of the mode in which the patients managed to respire without noise. M. Beau foresaw this objection, for he justifies the conclusion, that the air has passed into the bronchial system, from the continuance of the thoracic movements; but we have elsewhere proved (chap. II., art. 6) by our manometric experiments, that the penetration or expulsion of air might be suspended, notwithstanding the continuance of the thoracic movements.

Because bronchophony and pectoriloquy are the result of the reverberation of the voice through the lung, M. Beau concludes that bronchial and cavernous respiration are merely the result of the reverberation of the guttural sound through the pulmonary tissue. But the sole logical conclusion that can be drawn from the above facts is, that the guttural sound may be propagated to a certain distance from the place it originates. Now this proves nothing for the theory of M. Beau. Besides, the sounds of respiration cannot be transmitted to so great a distance as those of the voice; for we have proved, in our manometric experiments, that the latter require a much greater amount of motion than the former.

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* Beau, loco citato, p. 4.

Having repeated the experiments of M. Beau, we cannot agree with him, that the normal tracheal and vesicular sounds can be produced by blowing with a tube against the soft palate. Besides, even if this were so, still we could not arrive at any conclusion from it. Neither can we draw any conclusion from some other facts brought forward by M. Beau*, inasmuch as they are equally favourable to either theory.

It is indisputable that, in certain asthmas, we have diminution or even complete cessation of the inspiratory murmur, notwithstanding the convulsive motions of the chest†. In the panting produced by running, the inspiratory murmur is not entirely destroyed, it is only diminished in intensity and augmented in rapidity, but this may make us doubt its existence if we examine inattentively‡.

We cannot admit that the cessation of the respiratory murmurs is a favourable condition for hearing the pleuritic friction sound and certain ronchi, because this cessation supposes that the conditions of production of these sounds no longer exist.§

The guttural sound may be produced, notwithstanding considerable dilatation of the superior respiratory passages.‖

Each of these propositions, proved by experiment and observation, is opposed to those on which M. Beau builds his theory.

In conclusion, we may admit as facts incontestably established by the experiments I have related:

1st. That in the normal state there is produced in each section of the respiratory apparatus, from the buccal and nasal openings to the air cells, a peculiar sound, entirely independent of the sounds of the neighbouring sections.

2nd. That the sounds called vesicular and bronchial, considered in the normal and morbid states, originate in the air cells and the bronchi, and are the results of the passage of air through those cavities; that this is also true of the sounds of cavernous and amphoric respiration.

3rd. That the sounds of the superior respiratory passages, depending upon the mode in which the patient respires, may, according to their degree of developement and predominance, according to the conditions of conductibility of the lung, be propagated to the inferior respiratory passages, so as to be heard conjointly with the vesicular murmurs, from which they may be distinguished by their changeability, their metallic *quality*, and the character of remoteness.

4th. That there exists no direct relation between the guttural sounds and the vesicular murmurs, since the latter may disappear while the

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[*] *Loco citato*, p. 8 et 9. [†] p. 14. [‡] p. 13. [§] p. 14. [‖] p. 13 et 14.

former continue, and vice versa; that consequently, the presence of the guttural sound is not conclusive as to the penetration or non-penetration of air into the pulmonary cells.

That the absence or presence of the vesicular murmurs is the best means of judging of this penetration, whatever may be the conditions of the thoracic movements.

5th. That the pleuritic friction sounds and the ronchi are perceived more distinctly, in proportion as the vesicular murmurs are less diminished, that is, in proportion as the penetration of air into the pulmonary tissue is more marked. (34)

CHAPTER VIII.

MECHANISM OF PRODUCTION OF THE PHYSIOLOGICAL AND MORBID SOUNDS OF THE RESPIRATORY APPARATUS; REASON OF THEIR COEXISTENCE WITH INSPIRATION OR EXPIRATION.

When in any phenomenon its proper and distinctive characters are well analysed, and its relations with morbid anatomy, in the different periods of its existence, clearly established; its value, diagnostic and prognostic, is already determined, though we may be altogether ignorant of the mechanism by which it is produced. But this value is enhanced, if, knowing the laws that regulate its production, we can apply them to the particular circumstances in which the patient is placed. With the fact, we then have the principle that governs it, and we proceed with more security.

The sanction given by reason to the conclusions of sense, is a new guarantee for the result. This is the difference between principle and routine; in the one case we govern the phenomenon, we precede it in its course, or at least we follow it with intelligence: in the other we are governed by it, we observe it passively, we see it chiefly in the present, and if we can sometimes anticipate the future, it is by the aid of memory and not of reason. Hence the explanation coming along with the phenomenon is always useful, if it be accurate; it not alone gratifies curiosity, it guides observation, and exercises an useful influence on practice; but it is very difficult on account of the complexity of the phenomena; and in proportion as it is useful when true, is it mischievous when false, because an error of judgment easily induces an error of sense. We cannot therefore, I think, be too cautious in the explanation of phenomena, nor too exact in our mode of investigating the mechanism by which they are produced.

As the explanation is independent of the fact, I determined, in order to leave the mind free, the senses independent, and each result of its proper value, to keep the results of clinical observation distinct from those of study or of theory; the clinical facts already established will remain the same, whatever may be the fate of the explanations that form the subject of this chapter.

Some, of whose ability I have a high opinion, think that instead of ascending from the fact observed to the explanation, we ought to proceed in the opposite direction; that from the knowledge of the laws that regulate the production of the phenomenon, and from the actual existence of the conditions these laws suppose, we should infer the existence of the phenomenon; that we should inquire from physics what symptom ought to exist, instead of seeking there for an explanation of the symptom already observed and determined. This process may be happily enough applied to certain particular cases, but we cannot adopt it as a general rule; it would infallibly lead to a very great number of errors. In physics such a course is possible, in medicine it is not. In the former the effects result almost always from *necessary* causes; in the latter they usually depend on *eventual* causes. Now this manner of proceeding would suppose, that we always knew perfectly the physical and dynamical conditions in which the organs may be placed; it would suppose the exact knowledge of all the elements of the problem that each variety of morbid state represents, the knowledge of the relations and combinations of those elements, and the invariability of the symptomatic effects under the action of dynamic causes nearly the same in our modes of analysis. But we are very far from this. It is, therefore, absolutely necessary to proceed in quite another way: first, the labour of the senses, then that of the mind; first, to determine by attentive observation the existence and the particular characters of a phenomenon, the circumstances in which it is produced; and then to ascend from this, if it be possible, to the mechanism of its production; not to hazard explanations, unless they are founded on the laws of physics, the evidence of analogy, and not on individual opinion. Such is the course I thought myself bound to follow.

But whatever care we bestow on this inquiry, it cannot be expected that the explanations we offer should exhibit the degree of exactness proper to physical facts, because the purely physical elements that concur to form the problem are not so easily analysed here, and the dynamic elements combined with them complicate it still more. Hence I look upon them as but of very secondary importance.

Among these explanations, there are some I have merely verified; others are so simple and natural, that every one admits them, although they are no where formally laid down; lastly, others are peculiarly my own.

I have suggested or stated several of them in speaking of the particular and general clinical facts; to avoid repetition I will touch upon these again as little as possible.

ARTICLE I.

The *mechanism of production* and the *conditions of production* of a phenomenon should not be confounded. These conditions, which we have in general analyzed in speaking of the relation between each symptomatic fact and the pathological alteration that corresponds to it, exhibit the possibility of the phenomenon; the mechanism exhibits the phenomenon in action, and analyzes the mode in which certain circumstances concur to

this action. The mechanism of production of the sonorous phenomena supposes, as a preliminary study, an accurate knowledge of their conditions of production.

The key to the mechanism of production of these phenomena, is found in the analysis of the different combinations which the three following facts may form: 1°. the dynamic state; 2°. the physical state of the organ in which the sound originates; 3°. the conditions of conductibility of the neighbouring organs. These are invariably the three primary elements of the problem. It will be necessary to examine them each separately, then in their assemblage and in their relations. Certain general laws, a knowledge of which may greatly facilitate the analysis of the particular facts, or even sometimes lead us to foresee and discover them, are connected with each of these three principles, and control all their particular applications.

1st. The word *dynamic* expresses, in reference to the subject of this treatise, the force and velocity with which the air is drawn into and thrown out of the bronchial system.

Cæteris paribus, the sonorous phenomena of the respiratory apparatus are more marked, in proportion as the extent and velocity of the respiratory movements are greater, because there exists in general a direct relation between the pulmonary sounds and the thoracic movements.

But there is sometimes a great disproportion between the force expended and the intensity of the sounds produced. This fact is observed, when the lung, restrained by a false membrane, by a pleuritic effusion, &c. can no longer obey so well the lateral impulse of the column of air in inspiration. If asphyxia be impending, an inverse ratio is soon established between the effort made and the sounds produced. The patient vainly exhausts himself in convulsive efforts of respiration, and the air scarcely penetrates the air cells at all, whether there be organic narrowing of a part of the laryngo-bronchial system, or merely spasmodic contraction, as has been admitted in some species of asthma. In the first case, the resistance to the dynamic effort is at the periphery of the lung; in the present, it is at its centre. Percussion is sufficient to distinguish these two circumstances: in the first the sound is obscure or dull; in the other it is more developed than in the normal state.

All the sounds of the respiratory apparatus do not require for their production the same quantity of movement. For some a very moderate effort of inspiration and expiration is sufficient: such are in particular the sounds produced in the superior respiratory passages; such are the ronchi in which the bubbles are abundant and very humid. Others require a much greater effort: as the sounds that originate in the minute divisions of the bronchi, in the air cells, at the surface of the pleura; as the sounds that present the character of dryness and hardness, compared h those that are distinguished by an opposite character. Hence it is t we see this last class of sounds diminished very much and even

cease altogether, notwithstanding the continuance of their physical conditions of production, when the patient sinks into a state of great debility; whilst those of the first class are audible even to the last moment of life; for example, the ronchus of the dying compared with the dry crackling ronchus and the crepitant ronchus of pneumonia, as well as with the pleuritic friction sounds. It is easy to see the reason of this.

We know that the way to render the morbid sounds of the respiratory apparatus more distinct, is to make the patient respire with more force. We know that some vesicular ronchi are heard when the ear is first applied to the chest (see chap. II. art. 13), and that they afterwards become inaudible: the reason is that the first inspirations are stronger than the succeeding ones. The physical conditions of the lungs and the conditions of conductibility of the neighbouring organs remaining unchanged, we often see the physiological or morbid sounds exaggerated for a time, under the influence of mere nervous excitement. Puerile or supplementary respiration is nothing but an exaggeration of the respiratory forces, which concentrate their influence on the whole or a part of the lung. As long as the patient's strength continues good, there is thus, in general, an antagonism between the physical and dynamic state of the lung; should the physical conditions have a tendency to reduce the organ to a state of repose, by the obstruction they offer to the entrance of air, the dynamic effort increases, and tends to multiply the movement. Should the permeability of the organ be re-established, the dynamic effort is proportionally diminished.

The quantity of movement remaining unchanged, as well as the physical conditions, the form and nature of the sounds sometimes depend on the velocity and direction of this movement. Hence it is that we can at will produce or not the buccal, nasal, pharyngeal sounds; diminish or suspend one of the two respiratory murmurs. I have stated elsewhere (see chap. I. art. I. § 2, and art. II.) the general principles that govern the different forms of the respiratory sounds in the superior sections.

The mechanism of production of the respiratory sounds depends chiefly on the physical conditions in which the different parts of the respiratory apparatus are placed. The physical conditions and their influence in the mechanism of production of the sounds, may be reduced to three types: 1°. the greatest degree of densification, represented by hepatization, &c.; 2°. the greatest degree of rarefaction, represented by pneumothorax and emphysema; 3°. the liquid state, represented by pleuritic effusion. The laws of physics on the vibrations of solid, liquid, and aeriform bodies, may be applied to the analysis of the sounds produced in these three principal morbid conditions of the respiratory organs. Now, as all possible intermediate degrees between these types may be represented by the various morbid conditions of the respiratory organs, the mechanism of formation of the sounds produced in those intermediate

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states will be deducible from the laws that govern the vibrations in the typical states.

But we have two remarks to make in this place: 1°. The respiratory organs scarcely ever present in their alterations the precise physical states that the laws of physics suppose; hence these laws cannot be applied in an absolute manner in the investigation of the mode of production of the sonorous phenomena that result from them. Thus instead of an uniform, extended solidification of the pulmonary tissue, there most frequently exists an irregular or perhaps partial solidification, intermixed with a physical state directly the opposite, as in the hepatization of lobular pneumonia, or in tubercular infiltration of the pulmonary tissue. In such cases, effects, like their causes, may be combined, and neutralize each other in different ways; and it becomes then very difficult, often even impossible, to appreciate with exactness the different combinations of movements that in the end produced the sound we analyze. The same sonorous vibration may have to traverse in succession a solid, a liquid, and an aeriform medium; this is what takes place in hepatization of a part of a lung complicated with pleuritic effusion. 2°. The second remark I have to make, is that the different physical states which the alterations of the respiratory organs suppose, instead of being fixed, and capable of being calculated according to fixed laws in the mode of production of their effects, are sometimes very variable. Such are the situation and the quantity of liquids secreted in the interior of the bronchial system (different kinds of ronchi); we are then obliged, in the explanation of the phenomena, to speak conditionally and approximatively. The result of all this is, that the application of the laws of physics to the analysis of the mode of production of the respiratory sounds, diminishes in exactness and precision, in proportion as the alterations represented by these sounds depart more from one of the three types, *solid, liquid, aeriform,* and assume some of the intermediate degrees, or different combinations of these states; in proportion as the physical conditions represented by these alterations are less constant in their form and their degree. It results also from the preceding considerations, that in the investigation of the mechanism of production of the respiratory sounds, the nature of the elements that compose the problem is such, that the solution of it can only be approximative, and never, as in physics, absolute and rigorous.

The physical facts most capable of giving us an insight into the mode of production of the sounds of the respiratory apparatus are the following:

Every sound is the result of vibrations excited in the sounding body. Every vibration supposes a certain degree of elasticity*. The sounds produced in an organ correspond to its degree of elasticity; it is this makes the difference between the normal sounds of the superior and inferior sections of the respiratory apparatus; the vesicular sounds are very feeble, very dull, compared with the pharyngeal, buccal, nasal sounds; because the walls of the cavities, in which the latter originate, are much more elastic. If the pulmonary tissue be converted into a dense structure, or hollowed into cavities with hard, vibratory walls (pulmonary cavities, hepatization), we find as strongly marked sounds generated there as in the superior sections; for example, the bronchial and cavernous characters of respiration.

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* *Magendie,* Lecons sur les phenomenes physiques de la vie, t. 1, p. 166.

If the vibrations excited in a body are irregular, few in number, produced by an instantaneous shock, the impression felt by the ear has in it something abrupt and confused, and deserves only the name of *noise (bruit)*. If the vibrations are isochronous and sufficiently numerous to allow the ear to distinguish, if we may say so, a succession of slight strokes, each of which produces on it the same sensation, this sensation is called *sound* (*son*).* In the sound, the agitation of the body is more prolonged and more regular. The crepitant ronchus of pneumonia, bronchial, cavernous, amphoric respiration, metallic tinkling, the pleuritic friction sound in its third degree, the sonorous and sibilant ronchi, &c. may be ranked in the class of sounds; the resonance of the cough, of the monosyllabic voice, the pulmonary crumpling, belong to the class of noises. But with regard to auscultatory facts, this distinction between sound and noise is not of any importance; accordingly, we will continue to employ each indifferently. It may perhaps be of some use in practice, to bear in mind that in general the sound that leaves on the ear a rapid and confused impression, supposes an abrupt, rapid, and irregular concussion of the part that produces it; whilst the sounds whose impression is distinct and prolonged, suppose a movement more slow, more regular, and more durable.

In an elastic body, the sound is stronger in proportion as the vibrations are more rapid†. On this principle depends the increase of the intensity of the normal or morbid respiratory murmurs, in the direct ratio of the increase in velocity of the respiratory movements.

The intensity of the sound corresponds to the extent of the sonorous body, the amplitude of its vibrations, and the number of bodies that vibrate in unison with it; lastly, to the degree of silence that exists around‡.

Thus it is that the bronchial character of pneumonia and the sibilant ronchus of the bronchitis with which it is sometimes complicated, are more intense in proportion as the hepatized portion of lung is more extensive, as the force with which the air is projected into the bronchial canals is greater, as the surrounding parts are more dense, and as the vesicular respiration is more completely extinct. This principle is applicable to a great number of cases; it is one of those that explains best the varieties of sonorous phenomena which accompany the different physical states of the lung.

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* Physique de Beudant, page 185. Physique de Lamé, v. 2, p. 2.

† Physique de Beudant, p. 183.

‡ Ibid. p. 185 et 186.

The intensity of a sound is in the inverse ratio of the square of the distance it has passed over[*]. We know that the normal and morbid sounds are less distinct in proportion as we hear them at a point more remote from the place they originate. The distance to which they are propagated, all things being the same in other respects, is directly proportional to their intensity. Most of them do not extend beyond the lung in which they are produced. In many cases the primary crepitant ronchus of central pneumonia cannot even be heard at the periphery of the organ. The sonorous and sibilant ronchi are those that are transmitted to the greatest distance; their intensity too is in general very great.

All the different kinds of vibrations of which a sonorous body is susceptible, may exist in it at the same time without interfering with each other; so that the same body may at the same time propagate all the sounds, whether acute or grave[†]; their sonorous waves pass one over the other without breaking.[‡] It is for this reason that we hear different kinds of sounds in the same point at the same moment; that each of these sounds, produced by a certain combination of the physical and dynamic states of the organ or of the surrounding organs, may be perfectly analysed by the ear, and, after an accurate examination and comparisons guided by experience, may be referred to its real cause. Hence it is that auscultation alone, skilfully practised and seconded by a mind enlightened as to the results it furnishes, is in itself often sufficient to reveal the different physical states of the lungs, with a degree of precision that we could scarcely suppose possible.

The reflexion of a sound by the surface of an obstacle which the vibration encounters, produces an echo when the sound is repeated distinctly, and a resonance when the result is only a confused noise[§]. The resonance, however, does not always depend on the reflexion of sound; it often results from the vibration of the walls against which the sonorous wave impinges[||]. Pectoriloquy, bronchophony, egophony, bronchial cough, cavernous cough, may be considered a sort of echo of the cough and voice produced in the larynx. This echo, this reverberation varies according to the nature of the obstacle against which the sonorous waves happen to strike. The secondary vibrations, produced by the impulse of the primary vibrations on opposing bodies, differ from those and from each other, according to the density, the particular form, &c. of the bodies at the surface of which the echo is produced. The amphoric respiration, the cavernous respiration, which are produced in a vast tuberculous cavity; the metallic resonance, which I have said (chap. II.) is produced in certain cases of hydropneumothorax complicated with perforation; the metallic tinkling described by Laennec, may be considered as the resonance of a primary sound, a resonance produced at once by the reflexion of the bronchial murmur against the walls of the pulmonary or pleuritic cavity, and by the secondary vibration of those walls.

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[*] *Physique de Beudant*, p. 365.

[†] Ibid, p. 203.

[‡] Ibid, p. 368.

[§] *Ibid*, p. 370.

[||] Ibid, p. 371.

The differences of *quality* (timbre) exhibited by sounds produced in tubes of different texture, depend primarily on this texture, and their manifestation appears to be the result of the friction of the column of air against the walls and perhaps also of a feeble resonance of those walls themselves*. Thus these three principles are established: 1°. that the normal and morbid respiratory sounds may be produced, at least in part, by the friction of the column of air in inspiration and expiration against the walls of the bronchial tubes, as well as by the vibration of those walls themselves; 2°. that there exists a direct ratio between the difference in *quality* of the respiratory sounds, successively increasing as we ascend from the inferior to the superior sections of the apparatus, and the different texture of the tubes at different heights; 3°. that, from the knowledge of those laws and those relations, we may, as I have elsewhere observed (chap. I.), even *a priori* foresee what symptoms must present themselves, if conditions somewhat similar to those that the superior respiratory passages present in the normal state should be developed accidentally in the tissue of the lung itself. This, in fact, is what occurs in the progress of phthisis: the cavities which the disease has excavated in the tissue of the lung represent tolerably well, in some cases, the physical conditions of the pharynx, of the mouth, or of the nasal fossæ. Like those natural cavities, the excavations are placed at the extremity of a tube by which the air enters and escapes, and are like them circumscribed by vibratory walls; accordingly there is a great analogy between pharyngeal, buccal, or nasal respiration, and cavernous respiration.

The sound obtained by blowing into a tube is inversely as its length, all things being the same in other respects†. We know indeed that the respiratory sounds become more and more developed in proportion as they are heard nearer the larynx, the pharynx, the mouth, and the nasal passages. If we view each of these parts, and those of the bronchial system that lie below them, as distinct tubes, it is plain that their length diminishes almost regularly from the inferior to the superior sections of the respiratory canals.

When the mass of air, by which sound is propagated, is confined laterally, as in a cylindrical tube, the sound may be transmitted to a great distance without losing any thing of its intensity ‡. Let me add, that it may be propagated equally both upward and downwards, whatever be the direction of the column of air forming the sound; and even that it may reach the ear of the observer by traversing this column in a direction opposite to its own. Thus it is that the humid bubbling ronchi which are formed in the depths of the respiratory passages, are heard distinctly by the ear placed near the mouth of the patient, and are perceived during the inspiratory movement, which is the precise period of their formation. It is that the sonorous wave, once formed, radiates in every direction, and can traverse even a very rapid column of air, without being broken ; it is that sound passes through space with infinitely greater velocity than the most rapid current of air. This is the case of all movements of vibration compared with movements of translation. Hence it is that the pharyngeal, buccal, nasal, laryngeal sounds are propagated from above downwards, even to the inferior respiratory passages, and that they may be heard by mediate or immediate auscultation, at the very instant, we may say, of their formation.

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* Physique de Beudant, p. 361. † Ibid, p. 361. ‡ Ibid, p. 365.

When several sonorous vibrations originate at once in the same point or in contiguous parts, and are propagated beyond their place of origin, they can pass, as I have said, without interfering with each other ; but the weaker sounds are obscured or even completely masked by the stronger, *duobus sonoribus, vehementior obscurat alterum.* Hence it is that we do not always hear all the sounds that are produced, or that we do not hear them as distinctly as at the place where they originate ; in pneumonia complicated with bronchitis of the large branches, the sonorous and sibilant ronchi prevent us from hearing the crepitant ronchus ; in central pneumonia, the vesicular murmurs of the periphery of the lung, now more intense than in the normal state, interfere with the transmission of the crepitant ronchus and of the bronchial character to the ear of the observer. It is also the vesicular murmurs that prevent our hearing, in the normal state, the sounds of respiration in the bronchi ; but should vesicular respiration cease from any cause, the sound of bronchial respiration appears, even though the conditions of the organ as to conductibility have undergone no alteration ; for example, where several lobular bronchi happen to be obliterated, in such a way that respiration can still go on in their superior part.

When two bodies rub against each other, the moving body makes small successive jerks to pass the asperities over one another* In this principle, and in what we have already said on the dynamic conditions of the respiratory apparatus, is included the whole theory of the sounds that are characterized and produced by friction. Such are the pleuritic friction sounds (see chap. II. art. 12) : on the degree of force with which the two surfaces are impelled against each other, on the degree of proximity that exists between them, and on the degree of developement and hardness of the asperities, depend all the possible forms of pleuritic friction sound.

There are different types of sounds, all of which appear to be produced by a different mechanism. 1°. We have just seen that, for the *friction* sounds, there were forcible contact and motion between two uneven surfaces. 2°. The mechanism of formation of the sounds that I have called *bubbling* (bubbling ronchi) consists in the successive developement of a bubble of air in the midst of a humid atmosphere which forms its envelope, imprisons it for an instant, opposes more or less resistance to its enlargement, and at length bursts, allowing it to escape. 3°. The sound I have described by the name of pulmonary *crumpling* appears to be produced, as its name indicates, by the mechanism exhibited in crumpling, in squeezing a dry tissue. This sound is produced in the first period of pulmonary phthisis, and in cases where the lung is compressed by a tumour developed in its vicinity. The power that produces the crumpling is the column of air in inspiration, the tissue crumpled is the lung, and the resisting points, against which the inspiratory forces push the pulmonary tissue, are the small solid bodies developed in its substance. It will be recollected that in fact this sound coexists exclusively with inspiration, and that it increases a little in intensity when this movement is exaggerated. The slightly dry state of the tissue of the lung in the first period of phthisis, favours the developement of this kind of sound. 4°. What I have called the *crackling* ronchus seems to be produced by a different mechanism: the sensation is that of dragging and tearing the tissue; but no direct fact can absolutely authenticate this explanation. 5°. I have said at page 197 upon what the differences of *quality* depend and how they are produced. 6°. Those of *tone* depend on the number of vibrations in a given time. The production of the acute tone requires the greatest number of them, requires therefore the greatest dynamic power, and supposes the greatest physical obstacle to this effort. Accordingly, the acute tone, when it is conjoined in any form with the sounds of respiration or circulation, suggests a more unfavourable prognosis than the grave tone. 7°. The *intensity* of the respiratory sounds is determined by the amplitude of the vibrations that produce them. 8°. Their *duration* by the reproduction of the sonorous vibrations for a longer or shorter period, and hence by the more or less permanent action of the immediate causes that have determined the vibration of the sonorous body. These two latter circumstances of the respiratory sounds are principally influenced by the dynamic conditions of respiration. 9°. The *soft*, smooth, mellowy character, is produced by the contact and the action of the columns of air of inspiration and expiration upon a soft and flexible tissue, which freely expands under its influence. 10°. The *hard*, difficult character arises from a contrary mechanism; it is something that resists the movement produced by the column of air. 11°. If this air passes through a tissue more or less saturated with liquids, the *humid* character is produced; it takes the name of *viscid* if these liquids be a little glutinous. 12°. If the column of air penetrates a tissue somewhat dry and rather unyielding, the *dry* character is heard.

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* Physique de Beudant, p. 179.

From what I have said at page 197, the normal respiratory sounds appear to be produced by the shock, by the friction of the columns of air of inspiration and expiration, against the walls of the different sections of the respiratory passages; probably also by a little vibration of the walls of these passages, perhaps even, in the vesicular section, by the alternate folding and unfolding of the walls of the vesicles. It appears to be the same with respect to many of the morbid sounds.

Whenever a body produces sound, its particles possess a vibratory motion more or less rapid, which is sensible to touch.* These vibrations are propagated to a greater distance from the place they originate, and are more easily appreciated by touch, in proportion as their amplitude is greater, and their number in a given time less; that is, in proportion as the sound they produce is at the same time more intense and more grave. (See, for the applications of this principle to practice, 2nd part, Chap. VII. Art. I.) The effects perceived by touch are much less sensible than those perceived by the ear; the sound produced by the vibration of a body is very easily perceived at some distance from the place it originates; whilst the hand, placed at the same distance as the ear, for instance, on the walls of the chest, feels no trace of vibration.

Of the sounds that originate in a solid body, some are transmissible to the observer by the intervention of the air; these are *aerial sounds;* others cannot be propagated beyond the body in which they originate, except through the intervention of a solid substance; these are the *material sounds,* which are heard by mediate or immediate auscultation. It sometimes happens that these two classes of sounds are transformed into each other, that the material sounds are transmitted by the air, and the aerial ones by the stethoscope.† The sounds that originate in the respiratory apparatus are very seldom heard where they are generated. In general, to reach the ear of the observer, the sonorous wave is obliged to pass through a greater or less extent of the tissues. The tissues which lie in its course are usually of different densities, and according to their density, afford it a more or less easy passage, and vibrate more or less in unison with it. It results from this, that the sonorous vibration, when it reaches the ear, no longer bears its primary characters, but a mixture of characters more or less complex, resulting from the changes it has suffered in its route. The ear and the mind become habituated to distinguish, in this complex result, the principal elements of its formation, and to recognize the primary sound and the modifications which have been impressed on it by the conditions of conductibility it has had to pass through. We see from this how important must be the analysis of these conditions. The number of the vibrations of a vibrating body is always remarkably influenced by the bodies with which it happens to be in contact ‡. These principles apply at once to the signs furnished by auscultation, by percussion, and by touch.

Elastic bodies of the first species, that is, those whose change of form is instantaneous, are alone susceptible of producing sound by their vibrations. Elastic bodies of the second species (all ductile bodies) are not capable of producing sounds, because the return of the displaced parts to their natural position takes place too slowly. If we cover an elastic body of the first species with one of the second, and attempt to make the former vibrate, the sound produced will be very much modified, very much diminished, or even sometimes completely extinguished, according to the nature and thickness of the latter.* This principle is applicable both to the normal and morbid state of the respiratory organs: in the normal state the bronchi represent elastic bodies of the first kind, and the pulmonary tissue represents more or less those of the second kind; accordingly, in the healthy state, the sound of respiration in the bronchi is but very imperfectly or rather not at all transmitted to the surface of the lungs. But let the tissue of the lung, instead of being pervious to air, be converted by hepatization into a solid substance, the best conductor of vibration, and the sound of bronchial respiration will become distinctly audible; besides, the perfect silence which exists around the bronchi, from the cessation of vesicular respiration, favours the propagation of the central sound to the periphery of the organ. If, on the contrary, the pulmonary tissue is converted into a body more pervious still than in the natural state, as in emphysema of the lung, the conducting power being diminished, the sounds that traverse this tissue will arrive at the ear with less than their original intensity.

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* Physique de Beudant, p. 183 et 184.

† *MM. Cagniard* Latour et Mageudie.

‡ Physique de Beudant, p. 200.

Sound is heard much more *quickly*, and with *much more force*, through a solid body than through air†. Liquids are much better conductors than air‡; solids are better conductors than liquids. We have a proof of the first of these propositions in the examples I have just cited; and of the second in the comparative result of the reverberation of the voice in pulmonary emphysema and pleuritic effusion; every one knows that this reverberation is almost nothing in the former, and is very considerable in the latter. Lastly, we know that the voice, in traversing indurations of the pulmonary tissue, such as considerable hepatization, confluent tubercular infiltration, scirrhous or melanotic degeneration, frequently assumes a very elevated form, which rises sometimes even to pectoriloquy, while egophony, which results from the passage of the voice through a stratum of liquid, is always less intense.

Liquids in contact with a vibrating body may themselves vibrate*. But the mode of vibration of liquids is not exactly the same as that of solids, and this difference in the vibration must produce a difference in the sound that results from it; such is, apparently, the mechanism of production of egophony. The sonorous vibration generated in a lung condensed into a body more or less solid, is modified in traversing the stratum of effused fluid, and this modification produces the difference between bronchophony and egophony. At the same time, other circumstances independent of the presence of a liquid, and which seem rather to be connected with certain peculiar but inappreciable conditions of the larynx, may produce the egophonic voice (see Chap. II., Art. VII).

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* Physique de Beudant, p. 181.

† Ibid. p. 201.

‡ Ibid. p. 296.

§ Ibid. p. 296.

The intensity and velocity with which sounds are propagated by solid bodies, depend on the nature and interior structure of those bodies. Thus, solid bodies that are most homogenous and most elastic, conduct sound best*. We know, in fact, that when pneumonia occupies a considerable part of a lung at the same degree, bronchophony and bronchial breathing are incomparably more intense than when it exists here and there at different degrees. It is the same in uniform pneumonia of the entire mass of a lung, compared with lobular pneumonia; the same in regular confluent tubercular infiltration of the lungs, contrasted with irregular scattered infiltration. These facts are easily explained: when the induration of the pulmonary tissue is uniform, all the parts vibrate in unison with the point first struck, and its sound is augmented; when the density of the tissue is unequal, the different lines of vibration that have originated in the densest points are broken here and there on those that are less dense.

Instead of being uniform, regular, homogeneous, as in pneumothorax, in hepatization *en masse,* in abundant liquid effusion, the mediums traversed by the sonorous vibrations may present different degrees of density in different points of their extent. Then the sounds that result are more complex, and the analysis of their mode of production more difficult. In passing through the denser mediums the vibrations are strengthened; they are weakened in traversing those that are less dense and less elastic. These facts may be embodied in the following principles: if the sonorous wave encounter bodies that are susceptible of vibrating in unison, the intensity of the sound is augmented in proportion to the surface of the new body put into vibration; if, on the other hand, it meet in its course non-elastic bodies, or obstacles against which it breaks, the intensity of the sound is considerably diminished†. In these principles we have the explanation, apparently very difficult, of some of the signs of the earliest period of phthisis pulmonalis; we find, by auscultation, as we have said (Chap. VI. Art. II. § 8), augmentation of the intensity and of the duration of expiration, augmentation of the intensity and diminution of the duration of inspiration; the alterations of the intensity and duration depend here on two classes of causes altogether different; one which comes under the preceding principle, another that is foreign to it; the increased intensity of the two murmurs depends on this, that the primary vibrations, generated in the air cells, are strengthened in traversing the dense and elastic corpuscles that constitute the tubercles; the diminution of the duration of inspiration results from the smaller expansion of the cells, in consequence of the obstacle that surrounds them, as well as from the air penetrating fewer of them; the increase in the duration of expiration depends, apparently, on the change that has taken place in the elastic force with which the cells react, contract upon themselves, and expel the air that had expanded them. The principles I have just laid down are very fruitful in applications; but these applications to be accurate, demand in general a very delicate analysis of the physical conditions in which the affected organ and the neighbouring organs are placed; they require, therefore, an exact knowledge of the different anatomico-pathological states that belong to each affection. In some cases of tubercular infiltration confined to the centre of the summit of the lung, and of emphysematous distension of the outer layers, the signs furnished by the first alteration assume quite a peculiar character, and are invested with forms and an intensity different from their original forms and intensity in traversing the second. In general the signs are then very obscure, and consist simply of exaggerated respiration, with the character of roughness, of dryness, and of difficulty. It is well known that all the thoracic sounds which are heard on the sternal region, have somewhat greater intensity than in the adjacent regions, on account of the greater elasticity and vibratility of the sternum.

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* *Physique de* Bendant, p. 202.

† Ibid. p. 367.

From those general principles on the mechanism of production, and the transmission of sonorous vibrations, it is easy to pass to particular applications to which I have not alluded in explaining the principles. It is easy, in the great majority of cases, to explain in a satisfactory manner, the different forms, the varieties that the sonorous phenomena present, and to connect these explanations with considerations useful in diagnosis and prognosis. We will proceed with more steadiness in our plan of treatment, when we are fully aware of the nature, the degree, and the course of the disease.

I said at page 197 that the sonorous vibrations are transmitted unaltered to a great distance, when the mass of air through which they are propagated is circumscribed laterally; that accordingly sounds are transmitted to a greater distance, and more pure through a tube than in the open air. On this is founded the employment of the stethoscope. I have elsewhere said, guided by clinical observation, that as a general method, immediate auscultation appeared to me preferable to mediate. Theory conducts to the same conclusion; it must be obvious, in fact, that an artificial tube so coarsely constructed as the stethoscope, cannot have more power to collect and transmit sounds than the concha of the ear and the auditory canal, formed for this purpose by the hand of nature. An attempt has indeed been made to imitate the concha of the ear, whose office is to collect the sounds by enlarging the inferior extremity of the stethoscope; but it is a coarse imitation. Besides, where have we in the stethoscope such perfect conditions of elasticity and vibratility as exist in the cartilages and membranes of the external ear. Placed on the extremity of the stethoscope instead of on the walls of the chest, it seems to me that the ear is much less happily disposed for the attainment of its object.

I have said at page 200, that the laws which regulate the formation and transmission of the sonorous vibrations collected by mediate or immediate auscultation, were the same for sonorous vibrations excited by percussion and received by auscultation at a distance; the same for vibrations sensible to the touch. This is in general true, especially as far as regards percussion. Thus it is that the tactile vibrations which speaking or coughing produce in the walls of the chest, are diminished in cases of emphysema, and of pneumothorax; but they are diminished also whenever the density of the lung is increased, and diminished in the direct ratio of this density; a circumstance which is in opposition with the principle laid down in page 201, a principle which is indisputable, that vibrations are transmitted with more ease and freedom through solids than through aeriform bodies. In all cases of pleurisy with effusion, of very thick old false membranes surrounding the lung, of hepatization or tubercular infiltration of this organ, &c., we find, on the one hand, a striking augmentation of the intensity of the vocal resonance (auditory vibrations), and on the other a proportional diminution of the vocal or tactile vibration. There are other facts apparently contradictory to the principles I have laid down; but it is sometimes possible, more easily than in the preceding case, to reduce them to other principles, or to certain combinations of the laws already expounded. Thus, when a cavity is large, regular, superficially placed, and full of air, we usually find a stronger vocal tactile vibration than in the healthy state of the part; the reason is, that in such circumstances the cavity is in reality an organ that augments the vibration, and that it performs the part of the case of a musical instrument. When tuberculization occupies the central part only of the top of the lung, the exterior layers usually are emphysematous, and percussion, instead of the obscure or dull sound which we might expect to accompany the presence of tubercles, sometimes produces an exaggerated sound; but in such a case we may in general avoid mistake, by practising comparatively *profound* and *superficial* percussion (see 2nd part, Chap. VII., Art. II.) The best condition for the transmission of the tactile vibrations determined by speaking or coughing, through the pulmonary tissue, is the healthy state of this tissue. This fact, taken along with the fact of the non-transmission of these vibrations in cases of hepatization of the lung and of pneumothorax, would seem to authorize this opinion: that the physical condition most appropriate for the transmission of tactile vibrations, is a mass of air limited in extent, and divided by a great number of partitions into innumerable secondary masses; or perhaps this opinion: that whenever a body or one of our organs is altered from its normal texture, it becomes by this alone less suited to transmit tactile vibrations; making allowance, however, in each of these explanations, for certain peculiar cases, such as that mentioned above.

It is in virtue of its elasticity the lung contracts after having been distended*. This fact is rendered indisputable by the experiments of MM. Magendie, Dupuis, Piedagniel, and Berard the younger. It is on this reactive power possessed by the pulmonary cells, and the retrograde movement it communicates to the column of air that the expiratory murmur depends. *Cœteris paribus,* the duration and intensity of this sound are directly proportional to the force and the slowness with which this reaction movement is produced. The degree of reaction, that is the force with which the air cells contract, is usually proportional to the degree of dilatation of these cells by the column of air in inspiration; accordingly after a strong inspiration, the expiratory murmur is always more developed. We have already proved this fact by our manometric experiments (see chap. II. art. 6). The expiratory murmur is much more feeble than the inspiratory: this is natural, for the moving power represented by the elasticity of the pulmonary cells cannot be compared to that of the contraction of the inspiratory muscles. The intensity of the murmur of inspiration is represented by the number of cells that open to admit the air and by the degree of their expansion. The intensity of the murmur of expiration corresponds to the number of cells that react on the air and to the degree of this reaction. The duration of each depends equally on the degree of expansion and reaction of the cells and on the slowness or rapidity of these movements. These principles once established, we can easily explain the mechanism by which each of the modifications of these sounds is produced, and determine from these modifications, when they present themselves, the physical and dynamical conditions they suppose. But we must not forget, in this analysis, to take into account the conditions of conductibility which may, as we have proved at page 202, have a very considerable share in the production of the alterations of the intensity of the respiratory sounds. In the first stage of phthisis, the augmentation of the expiratory murmur arises chiefly from the conditions of conductibility and of increased vibration that exist in the lung. In pulmonary emphysema, this augmentation is chiefly influenced by the modification that has occurred in the elasticity of the air cells. These cells can act but slowly on the air by which they are distended; the rarefied pulmonary tissue has become a worse conductor of sound; accordingly the augmentation of the expiratory murmur affects its duration particularly. We might in the same manner analyse the mechanism of production of the different morbid varieties of the expiratory murmur; any one can easily do this for himself.

The bronchial character that appears in the first stage of phthisis, as well as in all indurations of the lungs, is produced by the same mechanism as that of pneumonia. With this may be combined the influence of increased vibration which I pointed out above. The different degrees of the physical state of the lungs explain the different degrees of alteration of *quality* that may precede or follow the bronchial character.

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* Magendie, Leçons sur les phenomenes physiques de la vie, t. I, p. 7 and 169.

In general, we find the expiratory murmur more marked in proportion as we examine persons of a more advanced age, and the inspiratory on the contrary diminished in the same proportion. The cause of this is that the pulmonary tissue tends to become more and more rarefied as we advance in life, and thus approaching the anatomical conditions of emphysema, it must produce the same effects: the dynamic force of respiration having diminished, the pulmonary cells emptying themselves but slowly and with difficulty on account of the great diminution of their elastic property, their dilatation by the effort of inspiration is but moderate; hence the decrease of the inspiratory murmur and the increase of the expiratory*.

The great intensity of respiration in the child is explained by the greater dynamic force, by the somewhat greater extent of the air tubes, by the great flexibility of the pulmonary tissue, which renders the dilatation of its cells very easy and very extensive. The somewhat more strongly marked expiratory murmur in the child than the adult depends on the greater elasticity of the tissue of the lung in the first period of life. Accidental puerile respiration is the result of an augmentation of the dynamic power, and the consequent penetration of air into a greater number of cells, the greater expansion and contraction of those cells. The great elasticity of the air cells in the child, the diminution of this property in the old affected with emphysema, conduct, as we have just seen, to nearly the same result, the augmentation of the expiratory murmur. But there exists this difference between the cases, that in the child, as in all cases of exaggerated respiration, there is at once augmentation of both the duration and intensity of the murmur, while in the old, affected with pulmonary emphysema, the increase affects chiefly the duration. In the first case, in fact, the cells forcibly dilated by inspiration, react strongly against the column of air; while in the other case, being but gently distended by this column, their reaction is at once feeble and slow. If with some we suppose that the cells and bronchial ramifications are susceptible of a permanent or alternate contraction which greatly diminishes their diameter, (for example, the spasmodic asthma of Laennec) we may easily, from what has been just said, explain the modifications that may take place in the inspiratory and expiratory murmurs, and the mechanism of production of each of these modifications.

We have supposed above, in explaining the mechanism of production of exaggerated respiration, that a greater number of pulmonary cells were then dilated by the air; in fact, M. Cruveilhier has observed, that there is always a certain number of vesicles in reserve, which expand to supply the place of those that happen to be more or less obliterated. There is, says he, between the air cells taken individually, the same mutual dependence as between the two lungs, or the lobes of the same lung. I was, besides, authorized to admit this fact from my experiments on sponge.

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* M. Andral has already made this remark and given this explanation, applying it to the respiratory murmur viewed *en masse*.—(Auscult. Med. ed. 1837, t. 1, p. 65.)

In our inquiries into the mechanism of production of the expiratory murmur, we have taken into account only the *elastic reaction* of the air cells and of the rest of the bronchial tubes, because, in fact, in ordinary expiration this appears to be the essential cause of the expiratory sound; but whenever the respiratory motions are exaggerated or spasmodic, we must combine with this first and chief cause the action of the thoracic walls and of the abdominal muscles. All these forces, however united, are still inferior to the inspiratory forces. At the same time, they strikingly augment the intensity and duration of the expiratory murmur.

Two primary conditions are necessary to the production of the ronchi: 1°. a cavity; 2°. a column of air moving in it. All the possible varieties of ronchi depend on the form or the size of the cavity, on the greater or less dryness or humidity of its walls, on the volume, the force, and the velocity of the column of air; all the varieties of ronchi may be explained by the different combinations of the preceding elements. It would be much too long to enter into all the details of this subject. With the general principles previously explained, and what I have just now said it will be easy to descend to particular applications. Besides this subject has been better studied than those I considered previously, which is an additional reason for not dwelling on it.

I have made some researches with the view of determining the manner in which certain morbid states of the lung are produced. These researches have led me to an knowledge of the cause and origin of the granulations of hepatization in the 2nd and 3rd stage and of pulmonary apoplexy. By this means, we are enabled to explain the mechanism of production of the humid ronchus with continuous bubbles of active sanguineous congestion, of the crepitant ronchus of pneumonia, and to understand the cause of the differences presented by the latter at different periods of its duration. I will commence by relating the anatomical fact on which these explanations depend.

The 27th April, 1836, at the hospital *la Pitie*, I examined the body of a man who had died at No. 36 ward of St. Michael, of considerable contraction of the orifices of the heart. An apoplectic nucleus of considerable extent occupied the middle lobe of the right lung. There was no rupture of the pulmonary tissue apparent; the blood was, as it were, intimately combined with the tissue, and no where presented the appearance of an isolated clot. An incision was made through the centre of the apoplectic nucleus; the surface of this incision was granular. The maximum of alteration and of granulation was at the centre; both decreased in proportion as we receded from that point. I proceeded to examine from the circumference towards the centre. Here where the granulations were in quite a rudimentary state, it was easy to see with the naked eye, as well as with a glass, that they were produced by a slight projection of the points of intersection of the walls of the cells; these cellular walls were slightly thickened, firm, and as if in a state of turgescence. This thickening, this turgescence on which depended the granular condition of the cut surface, was owing to the deposition of a thin layer of blood on the inner face of each of these walls. This blood was apparently intimately combined with the tissue of the walls, which appeared on the surface of the slice, as innumerable little projections inclosing between them small areolar spaces. These projections were nothing else but the granulations described by Laennec, and the areolar spaces, presenting little depressions, were what remained of each vesicular cavity. But as these little depressions exhibited a somewhat greater capacity than the pulmonary cells in the normal state, we were disposed to think, either that these cells were greatly dilated before the hæmorrhagic congestion, or that each of these little depressions was formed of two or three cells united into one by the rupture of their walls. Whichever it may have been, each of these little cavities was lined within by a layer of sanguineous matter, which diminished its capacity, and which could be partially removed by scraping the interior of the cavity with the point of a fine scalpel. In proportion as we approached the centre of the apoplectic nucleus, we saw the granulations on the surface of the slice become more marked, the little vesicular cavities more and more diminished, and at length completely filled up by the sanguineous matter deposited on the inside of their walls; we saw these walls become thicker and more resistant, and produce still more plainly, by their mammiform projections, the small granulations so well described by Laennec*. On washing and compressing the portions of pulmonary tissue on which we had made these remarks, a considerable quantity of the blood it contained came away, the granular appearance was proportionally diminished, the surface of the slice became more smooth, and we could recognize in it the walls of the little cells reduced almost to their natural thinness and prominence. The small lamellæ that formed these walls merely retained a little of the blood they had imbibed and a slight reddish tinge. In the intervals between these lamellæ the small vesicular cavities were seen, now perfectly distinct and having resumed nearly their natural capacity, but sunk in upon themselves. In the parts most distant from the centre of the apoplectic nucleus, where the granular condition was altogether rudimentary, the disease scarcely deserved the name of apoplexy. I made afterwards researches similar to the above on persons who had died of pneumonia in its 1st, 2nd, and 3rd stages, and I ascertained precisely the same facts. The granulations are altogether rudimentary in the 1st stage; in the 3rd where suppuration begins to take place, it appears first on the granulations themselves, in the form of a white point, then extends, and gradually produces the softening and

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Auscult. Med. ed d'Andral, t. 1, p. 450. Forbes's transl. p. 188.

pneumonia, when the suppuration is somewhat advanced, the granular condition of the cut surface of the hepatized part has almost entirely disappeared. The suppuration of the lung therefore begins in the intervesicular cellular tissue and not in the interior of the vesicles. The absence of granulations in the alteration that has been called splenization of the lung* depends on this, that the organic action is in it altogether different from that which takes place in pneumonia and pulmonary apoplexy. In the latter, a kind of inflammatory, congestional, hæmorrhagic turgescence of the walls of the cells takes place; but this turgescence is essentially active; there is an afflux of liquid into their tissue, and they become more consistent and more firm; hence the granulations. In splenization on the other hand, the blood transudes passively and is decomposed; the vital activity is greatly diminished in both solids and fluids; the walls of the cells give way, sink in, soften, and the splenified portion of lung in no long time falls into a pulpy detritus. We find this species of alteration occur chiefly in the old, or in persons worn out by a tedious illness. It has been remarked that the granular condition is, in general, less marked in hepatization of the lungs in old persons than in adults; this may also depend, as has been observed by M. Andral†, on the extreme rarefaction of the lungs in the advanced periods of life; their cells at this time are not so easily filled up by the thickening of their walls. The dyspnea also that accompanies the pneumonia of the aged is much less urgent than that which accompanies the pneumonia of the adult. MM. Hourmann and Dechambre, in an excellent work they have published on the pneumonia of the aged, have admitted two varieties of it; one of these has its seat, according to those authors, in the walls themselves of the vesicles; this one alone exhibits in its anatomical characters the granular condition. This fact, it is plain, is in accordance with the result of my researches on the nature and mode of developement of these granulations. I am aware that this result is opposed to the opinion of those whose name alone is a high authority, who place the seat of pneumonia and of the granulations that result from it in the vesicles themselves ‡.

For this reason I considered myself bound to give a detailed account of the facts on which I found my opinion. The notion, that the form and volume of the granulations depend on the vesicles in which they are supposed to be developed, is ingenious; it is the first that presents itself to the mind, but I believe it to be contrary to observation. According to this view it would be necessary to admit that each granulation was a kind of small sanguineous clot; now direct examination gives precisely the opposite result. The opinion I have put forward is quite in harmony with the ideas generally received as to the seat of inflammations. From the facts on which my opinion is founded, pneumonia is seated in the connecting cellular tissue of the mucous lamellæ that form the air cells, and begins by a hyperemia of this tissue; in consequence of this hyperemia, a slight sanguineous exudation is produced on the mucous surface, and not a real hæmorrhage as the other view supposes. This extravasation of blood, in the form of small clots, did not exist even in the apoplectic nucleus of which I have given a description; and yet this part presented all the characters described by Laennec as belonging to pulmonary apoplexy. Can persons have formed a false notion of the mechanism of production of this affection from its minor degrees? The pathogenic course I have described in pneumonia agrees with that observed in inflammation of the bronchial and of other mucous membranes.

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* Auscul. Med. t. 1, p. 454 et 455.

† Idem, t. 1, p. 650.

‡ Louis, Recherches sur la Phthisie, p. 9.—Laennec, ed. d'Andral, v. 1, p. 491.—Forbes's transl. p. 201.

These anatomical facts being established, let us see how they explain the characters exhibited by the humid ronchus with continuous bubbles of active congestion, and the crepitant ronchus of pneumonia. The active sanguineous congestion precedes, as we have said, the first stage of pneumonia, and the continuous humid ronchus precedes the crepitant ronchus (Chap. VI. Art. 2, § 3). If the parallel we have made between those two ronchi (Chap. II. Art. 11,) be borne in mind, it will be seen that their differences correspond to the different forms and degrees of the anatomical state on which they depend. The bubbles of the ronchus of active congestion are voluminous, and as it were continuous with one another; they are accompanied with the viscid humid character; in fact at this period the air cells are less obstructed; the blood which is beginning to be exhaled at their surface and deposited on their walls, has not as yet become solidified, as subsequently occurs; and the viscidity of this fluid is an obstacle to the free, rapid, and complete developement of the bubbles; hence the humid, viscid, and continuous characters they present. When the blood deposited on the walls of the air cells is in some degree solidified, when the capacity of the cells is sensibly diminished by the deposition of successive layers of blood on their walls, the bubbles of the ronchus formed must be dry and very small compared with the preceding; they must be more perfectly spherical, because the viscid quality no longer exists to oppose their developement. In proportion as, by the passage of the pneumonia from the 1st to the 2nd degree, the cells become obstructed more completely and in greater number, the bubbles must become finer and less numerous; they must cease entirely when the obstruction of the air cells is complete, and not reappear till the resolution of the obstruction is so far advanced, that the air begins to obtain admission into the vesicles; then a mucous secretion usually taking place at the interior of the vesicles in which resolution has commenced, the bubbles of this ronchus redux must be successively more humid and larger. Now this is precisely what happens; for we see in this description the three stages (appearance, cessation, reappearance,) of the crepitant ronchus of pneumonia, and the characters that are peculiar to it at each of its stages.

I made some experiments on a patient on whom I had operated for empyema, which appear to me to show conclusively the mechanism of production of the amphoric character, and of metallic resonance and tinkling.*

On the 2nd day of the operation, we recognized all the signs of hydropneumothorax with perforation of the lung (see Chap. VI. Art. 4, § 4), except amphoric respiration which was only heard at times for a moment. It was the first time these signs had appeared. The chest contained a considerable quantity of liquid and much air; astringent injections were injected every day into the cavity of the pleura, and we could without causing the slightest inconvenience to the patient, augment at pleasure the proportional quantity of air and liquid contained in the pleura. Fluid was thrown in till it rose above the level of the external wound; a female catheter was introduced through the wound and pushed into the mass of liquid; the edges of the wound were kept closely attached against the walls of the catheter, so that not a bubble of air or drop of liquid could enter or escape. We placed in the opening of the catheter the pipe of a syringe, charged with both air and liquid, and held slanting from above downwards, so that the air must pass in last. We directed the patient not to respire for some instants that we might be certain the sounds we heard were really the result of the experiment and not of respiration; I satisfied myself indeed that he did not respire; and while I kept my ear applied to the side of the chest ready to observe the sounds that might be produced, an assistant pushed the piston of the syringe. So long as it was the column of liquid that passed into the pleura, I heard no sound at all analogous to the normal or morbid sounds of the respiratory apparatus; the kind of bubbling produced was indeed barely perceptible. But the moment successive, scattered bubbles of air began to escape from the syringe, and traversing the stratum of liquid burst at its surface, I heard distinctly as each bubble broke, a clear isolated metallic sound, the same, in short, in every respect as the isolated metallic tinkling we heard in the same patient, in the same side of the chest, during respiration. In a second experiment, the syringe was charged with a greater quantity of air than on the first occasion; the piston was pushed more rapidly, and I heard the metallic tinkling less isolated, and accompanied with a kind of metallic resonance, such as is heard in some patients, and which I formerly described. Lastly, the syringe was charged with air alone, the piston was forcibly driven down, and the air instead of passing through the liquid bubble by bubble, traversed it in a dense mass, and came with a sudden reverberation against the bare sides of the pleuritic cavity. The sound produced was but a degree higher than the metallic resonance just described; it strikingly resembled amphoric respiration. But we produced a much better imitation of the amphoric character, by injecting the column of air directly into the portion of the pleuritic cavity not occupied by liquid. In doing this, care was taken to allow enough of the liquid to escape through the wound, that its level might be below the opening. These experiments, which were in no way injurious to the patient, were often repeated and always with the same results, varying merely in degree or form. Made on the dead body, their result is negative. In that case certain circumstances, not easily appreciated, prevent the exact repetition of the same phenomena. Some days before the patient's death, we again ascertained that metallic tinkling and resonance were produced naturally during respiration. The amphoric character was only audible at times. On examination after death, we found an effusion of air and fluid in the pleura, and below the level of the fluid a perforation of the lung, produced by a very narrow opening, through which the bronchial system communicated with the cavity of the pleura*. The lung being placed in water, and air injected into the bronchi, it escaped from the small opening in successive small bubbles, which burst in succession at the surface of the liquid; these bubbles were more scattered or more crowded together, according to the force with which the air was thrown in. I think we may conclude from the experiments I have just related, and from the relation that exists between the results they have furnished and the anatomical circumstances revealed by the autopsy: 1°. That the metallic tinkling of hydropneumothorax, complicated with perforation of the lung, is produced by a bubble of air which escapes from the lung through the fistulous opening, traverses the mass of liquid effused into the pleura, and bursts at its surface in the midst of the air more or less rarified, that occupies the upper part of the cavity of the pleura. The metallic tinkling produced, is isolated or prolonged according to the number and velocity of the bubbles of air that escape from the lung. 2°. That the anatomical condition of production of this sign is a very small pulmonary fistula, opening below the level of the effused fluid, a fistula of such a kind, that the air can only escape from it in the form of successive bubbles. It will be remembered, that metallic tinkling is best heard during coughing or speaking, that these acts require a greater respiratory effort, and that in such circumstances a greater number of bubbles find their way through the opening, than could have passed during a weaker dynamic effort. A very deep inspiration produces the same effect. 3°. That metallic resonance is produced in the same anatomical conditions, provided the air escapes in numerous bubbles rapidly succeeding each other, instead of in separate scattered bubbles. In fact this variety of the phenomenon occurs chiefly in consequence of great efforts in coughing, speaking, or respiring. 4°. That amphoric respiration is produced, when a tolerably strong column of air is poured directly or almost directly into the portion of the pleuritic cavity not occupied by the effused liquid. This condition is fulfilled by a fistulous opening rather large, and opening above, or at least near the surface of the effusion. It will be easy to conceive, with the aid of this explanation, all the varieties that may occur in the progress, in the form, in the different combinations of these three phenomena. We know there exists a kind of opposition between metallic tinkling and amphoric respiration; when the one is heard, the other in general does not exist; this must be so, inasmuch as the conditions on which they depend are nearly opposite. If two fistulous openings exist, one rather large and situated above the surface of the effusion, the other small and below this surface, it is plain the two phenomena may exist at the same time. If the quantity of the effusion be increased or diminished, so that its surface rises above or falls below the perforation in the lung, metallic tinkling and amphoric respiration may alternately replace each other. If the fistulous opening, small at first, becomes enlarged, the metallic tinkling will disappear, and will be replaced by the amphoric character. The contrary will take place if the opening, at first tolerably large, should happen to be diminished by the intervention of a small portion of detached pulmonary tissue, by a pseudo-membranous clot, or in any other way. Lastly, the two sounds I have analyzed will cease, if the fistulous opening should be completely obliterated, as I have ascertained on the autopsy of some patients in whom we had recognized, some time before death, the disappearance of metallic tinkling and amphoric respiration. The degree of force with which inspiration is effected, may likewise, as we have proved, exercise an influence on the degree, and even on the existence of those sounds. When metallic tinkling and the amphoric character both occur nearly at the same instant, and by one and the same fistulous opening, neither one nor the other assumes its most marked form or its highest degree of intensity. The predominance of one or other in that case depends chiefly on the degree of force with which the patient respires; the amphoric character prevails when the respiration is strong; the metallic tinkling when it is feeble. It is generally in the complex case I am considering that the peculiar sound is produced, which I have described by the name of metallic resonance. In fact, this is but an intermediate sound between metallic tinkling and amphoric respiration, but the passage from the first of these sounds to the second; it is, therefore, natural that it should present itself chiefly when the fistulous opening, in its diameter, and in its relations with the surface of the effusion, is as it were, intermediate between the anatomical conditions of metallic tinkling and those of amphoric respiration in their most perfect forms.

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* Ward of St. Louis, hospital of la Charite, under M. Andral in 1837.

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* There was no trace of tubercles in any part of the lungs in this case. The perforation was produced by a deep ulcer of a false membrane, which was thick, firm, and very old, and which covered the whole surface of the lung. This membrane was covered with ulcers, one only of which had reached the lung. A purulent fluid occupied the lower part of the cavity. Instead of proceeding, as usual, from within outwards, the perforation in this case was produced from without inwards. I believe no similar fact is on record.

I rejoice that the result of my experiments on this subject, agrees with that obtained by two such observers as Dance and M. Beau, (Dict. de Medic. 2^e edit. t. 4, p. 410; Archives de Medecine, t. 4, 2^e serie, p. 436). I think, with the authors of the Compendium de Medecine Pratique (t. 1, p. 477), and with M. Raciborski, (Laennec Française, t. 9, No. 83, p. 370,) that the explanation of metallic tinkling given by Laennec is applicable in certain circumstances where the above is not; and, therefore, that it must still be preserved for some particular cases.

ARTICLE II.

With respect to the causes that determine the coexistence of the morbid sonorous phenomena of the respiratory apparatus with inspiration or expiration, I will confine myself to offering the following considerations.

The coexistence of the acute-toned dry bronchial ronchi with inspiration chiefly, and of the grave bronchial ronchi with expiration*, seems to arise from this, that the column of air in inspiration, moving with more force and velocity than that of expiration, is, for this reason, placed in more favourable conditions for determining, by its friction against the bronchial walls, more numerous and rapid vibrations, and consequently more acute sounds. Moreover we may observe, as sustaining this view, that the column of air in inspiration traverses tubes successively more and more narrow (each section of the bronchial system being considered separately), and that on the other hand, that of expiration passes through tubes the diameter of which is successively increasing. In the first case, the velocity and consequently the number of vibrations increase in proportion as the diameters of the tubes diminish; in the second, both diminish in proportion as these diameters increase. Besides we know that the sound produced in a funnel-shaped tube is grave if we blow into it from the small towards the larger opening, and acute in the contrary case.

Sometimes the sibilant ronchus is heard at the same time during both periods of respiration; in this case we find it stronger and more noisy during inspiration, and this from the influence of the causes I have just pointed out. The sibilant ronchus is, in general, more acute in bronchitis of the small ramifications, than in that of the larger bronchial tubes; a circumstance which made M. Delaberge† justly remark that the sibilant ronchus that coexists chiefly with inspiration indicates particularly bronchitis of the small bronchial tubes, while that which is produced in expiration announces bronchitis of the larger. Because in fact, as we have just remarked, inspiration is more capable than expiration of producing vibrations in the small tubes.

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* The authors of the Compendium de Medecine Pratique (vol. I, p. 483), say that the sibilant ronchus coexists chiefly with expiration. I think this is a mistake, for I have in general found it the reverse.

† *Comp. de Med.* Prat. vol. 1, p. 483.

If the pulmonary crumpling sound and the dry crackling coexist altogether, or very nearly altogether, with inspiration, it probably arises from this, that the column of air on entering the lung, is obliged to dilate in every direction the cells of which that organ is composed, to produce a kind of unfolding of its tissue, and in this way to compress it against the foreign bodies (tubercles, &c.) that obstruct its developement. Expiration on the other hand acts in the opposite way; and if the cells, in sinking in, suffer a certain degree of compression and of crumpling against these bodies, it is but very slight; and hence the traces of crumpling and dry crackling sounds that are sometimes perceived in expiration are always very slight.

The exclusive, or nearly exclusive coexistence of all the fine bubbling ronchi with inspiration may be thus explained: these ronchi derive the spherical form and small size of their bubbles chiefly from the cellular form and small diameters of the section of the respiratory apparatus in which they are produced; the expansion of the pulmonary cells is absolutely necessary in order that a bubble should be produced and, as it were, moulded in their interior. Now, this can occur only in inspiration, for in expiration on the contrary the sides of the cells sink in and their cavity is effaced.

If the bubbling ronchi coexist less exclusively with inspiration, and more equally with the two periods of respiration in proportion as their bubbles are larger or more humid, the reason is that these two circumstances, size and humidity, suppose much larger cavities than in the preceding case, and much more liquid in these cavities; now, in these two physical conditions, the motion of the column of air in expiration is quite sufficient for the production of a bubbling ronchus, that is, for the passage of the air through the midst of mucous or purulent fluids.

I have referred to cases of pneumonia in the 3rd stage, in which there existed a mucous ronchus distinguished from the other ronchi of the same name by its exclusive coexistence with inspiration. It appears to me that this exclusive coexistence may be naturally enough explained thus: in the anatomical conditions in which the lung is then placed, the column of air in expiration has no force whatever; the only influence it can exercise is on the mucosities contained in the bronchi, producing thus the ordinary mucous ronchus; whereas the column of air in inspiration still retains a certain degree of force, a force that enables it to penetrate and find in the midst of a softened and suppurated tissue, or at least in the last ramifications of the bronchi which still remain free, the three conditions necessary for the production of a *bubbling* ronchus: 1°. a column of air in motion (inspiration); 2°. a cavity of small extent (resulting from the softening of the pulmonary tissue, or represented by the last bronchial ramifications that remain permeable); 3°. liquids collected in these little cavities (pus, mucosities).

I have remarked, in another part of this work, that the ronchi which coexist with inspiration alone, are in general of more serious import than those that coexist at once with both periods. This depends on the circumstance to which I have already several times pointed attention, that is, on the physical state of the lung, which renders altogether powerless the column of air of expiration, and leaves inspiration alone the power of producing ronchi.

If the alterations by augmentation of the respiratory sounds belong more peculiarly to expiration than to inspiration, and if they are more serious in the first than in the second, this results from the different mechanism by which these two movements are produced in the pulmonary cells. These cells are passive in inspiration, active in expiration. Not having any proper action in the production of the inspiratory murmur, they cannot of themselves and directly influence the augmentation of this sound; no direct relation connects the augmentations of the inspiratory murmur with the alterations that take place in the cells. Whereas, these same cells having in themselves their expiratory force, that is, their elasticity, have also the power of modifying the expiratory murmur by the changes that occur in this property. Now, we have already said that, in whatever way this property may be modified, the result always is an augmentation of the respiration; an augmentation which affects chiefly the intensity of the sound when the elasticity is increased, and chiefly its duration when this property is diminished.

Jackson*, a young physician of Boston, who had commenced some admirable investigations respecting the phenomena I am analyzing, and who died too soon for science, ascribed the coexistence of the bronchial character with expiration before it is audible in inspiration, to the natural feebleness of the expiratory murmur. The comparative feebleness of the expiratory murmur allows us, said he, to hear the sound of bronchial respiration, whilst it is still masked by the stronger murmur of inspiration. It seems to me that this explanation cannot be absolutely admitted. In fact, the expiratory murmur has in general already acquired the duration and intensity of the inspiratory, when the bronchial character, or even alterations in *quality* of a lower degree, begin to appear exclusively in it; the inspiratory murmur is often at the same time diminished. Moreover, when the alterations of *quality* have attained such a degree as to coexist with both periods, we find them always preserve greater intensity in expiration; and yet, at this stage of the disease, the inspiratory and expiratory murmurs, considered independently of their alterations of *quality*, are in an inverse ratio to that supposed in the explanation of Jackson; the first is diminished, the second increased. But if we cannot always explain in a very certain manner why alterations of *quality* coexist with expiration sooner than with inspiration, we can easily understand why there comes a time when these alterations of *quality* coexist with both periods; it is that they have then acquired such an intensity, that the inspiratory and expiratory murmurs, whatever they be, can no longer mask them.

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* *Memoires de la* Societè Med. d'Observation, t. 1, p. 15.

The coexistence of the dry and humid characters with inspiration peculiarly depends on this, that the column of air in inspiration strikes with more force the pulmonary cells, whether dry or humid. It depends also on this, that the expiratory murmur being more feeble than that of inspiration, the ear finds it more difficult to appreciate these characters during the sound on which its attention cannot be so long fixed.

I have said (Chap. III. Art. 12,) that the intensity of the pleuritic friction sounds was directly proportional to the extent and force of the locomotive movement of the lung, to the degree of approximation between the two pleural surfaces, and to the prominence of their asperities. Now, it is easy to see that the two first conditions are better fulfilled by inspiration than expiration; and hence the coexistence of these sounds more peculiarly with the first of these periods.

APPENDIX.

NOTES BY THE TRANSLATOR.

(1.) With the exception of Sir James Clarke, whose work on consumption is occasionally quoted, M. Fournet scarcely refers to a single English writer throughout his entire work. And yet for many years this country has kept pace with France, at times even anticipated her in the application and advancement of the "new science;" and thus, indeed, some facts apparently new to M. Fournet have long been familiar to physicians here. We must not therefore, in our just admiration of Andral, Louis, &c. forget the services rendered to auscultation by those to whom we are indebted for its early introduction and cultivation amongst ourselves. Dr. Forbes may be considered the first, as he is still the most zealous labourer in this field of science. The immortal work of Laennec appeared in 1819, the English translation in 1821. A few years later Dr. Forbes published his interesting volume of "Original Cases," and in 1827 a second edition of the translation; by this time the work was in the hands of almost every English student. Two or three editions of it have since appeared, while in the Cyclopædia of Practical Medicine and the "Review" he has been unceasingly engaged in promoting the study of this branch of medical knowledge. Next in point of time, but second to none in the ability and success with which he has prosecuted this subject, is Dr. William Stokes. The "Introduction to the Stethoscope" was published so early as 1825; since then he has, in a series of original researches, illustrated various auscultatory questions of great pathological and practical importance; while the Treatise on the diagnosis of the diseases of the respiratory organs has been hailed as a standard work by the unhesitating voice of the profession in this and other countries. Dr. Williams deserves a place among the foremost in this march of improvement. The "Rational exposition of the physical signs, &c." was published in 1828; his explanations of these phenomena contributed to render the study of auscultation more easy and more agreeable; and indeed there is scarcely any branch of it upon which light has not been thrown by his ingenious investigations. After this period, the writers on the subject become so numerous that it would not be possible to notice them all here; but I cannot pass unmentioned two, who, as teachers of clinical medicine, even more than by their writings, were amongst the earliest and most successful promoters of the study of auscultation, but whose merit in that respect has been in some degree obscured by their brilliant labours in other walks of medical science, Dr. Duncan, jun. who was, I believe, the first that actually employed the stethoscope in these countries, and Dr. Graves, to whom the clinical school of medicine of Dublin may be said to owe its existence and much of its celebrity.

It may be remarked that for some years past the attention of observers amongst us has been more particularly turned to the auscultation of the heart, the respiratory organs being comparatively neglected.

(2.) This proposition will, I have little doubt, startle the reader, who most probably has been accustomed to consider the respiratory murmur as belonging to the period of inspiration alone, and to look on that of expiration as unattended by sound. In fact, many even of our most practised auscultators appear to be still altogether unconscious of the existence of an expiratory murmur in the healthy condition of the lungs, and some who admit its existence are evidently very imperfectly acquainted with it. Yet its presence in the healthy state, as well as its value as a sign in certain morbid conditions of the respiratory organs, have for many years been recognized by Andral, Louis, and others of the Parisian school, and so far back as 1836, the attention of the profession in these countries was particularly directed to it by Dr. Cowan of Bath, in an excellent paper in the London Medical Gazette.

I am anxious thus early to call the student's attention to this most important, and, probably to him, novel fact—the constant presence of an expiratory murmur in natural respiration—with the view of inducing him at once to examine and satisfy himself upon the point. This previous study will enable him to follow M. Fournet in his researches with more satisfaction and more profit; I may add that he will in practice find a familiar acquaintance with this sign, a most valuable aid in the attainment of the main object of this work—the detection of phthisis at an early stage. Let him examine and judge for himself. With a practised ear and due attention he will rarely fail to find it. But considerable attention is sometimes required, as well as an ear familiarized with this particular sound. Nor should this surprise any one accustomed to auscultatory studies. Who does not know with what difficulty the ear educated to one class of sounds comes to appreciate a different class with equal accuracy? The fœtal heart, when audible, produces a very distinct sound, yet I have seen many persons, dexterous enough in the auscultation of the pulmonary organs, unable to detect it for weeks after it was perceptible to one more accustomed to obstetric auscultation.

(3.) We have no word in our language answering to *timbre.* It has been at times translated by *tone*, but this word is here employed in its proper acceptation. "Suppose two different instruments—a violin and flute for example—to sound the *same note* with the *same intensity* and for the *same length of time;* there will still be a certain peculiarity in each of the notes produced, distinguishing it from the other—that peculiarity is its *timbre*" (Review of M. Fournet's book in the British and Foreign Medical Review, No. 18). After the example of the able writer I have just quoted, I employ the word *quality* to express this property of sound, rather than introduce into the text a word so uncongenial to our tongue as *timbre.*

(4.) An account of Dr. Spittal's experiments will be found in his Treatise on Auscultation (the Harveian Prize Essay for the year 1829.) They were instituted with a view of showing that Dr. Williams was in error, in supposing the primary crepitant ronchus of pneumonia was produced by the "bubbling passage of air forcing its way through a *viscid liquid* contained in an infinity of tubes of equally diminished calibre"—an opinion which seems to have been very generally adopted by the profession. The result from Dr. Spittal's experiments was, as stated by M. Fournet, that a sound very similar to the fine crepitant ronchus is produced by the bursting of minute air bubbles on the surface of fluids of *about the same density and tenacity as serum;* but that this resemblance ceases in proportion as the fluid is more dense and tenacious. In viscid fluids, such as the expectoration peculiar to pneumonia, agitation produces scarcely any crepitus.

(5.) Dr. Cowan should not be omitted in this enumeration. In the notes to his translation of Louis on Phthisis, published in 1835, he more than once points out the importance of the study of the expiratory murmur, as a means of diagnosis in the earliest periods of that disease. The paper already referred to, published the following year, is expressly devoted to the consideration of this phenomenon, of which he gives a *very full* and accurate account, examining it under nearly the same points of view as *M. Fournet; its existence* in the normal conditions of the lung; the alterations it suffers in emphysema, and induration of the pulmonary tissue; its mechanism of production, and in particular, its value in the diagnosis of the earliest stage of phthisis. This paper, as well indeed as the whole series of which it forms one, is well worth an attentive examination; it will be seen that the French writer has been anticipated in other respects by Dr. Cowan. It is, perhaps, easy to account for M. Fournet's ignorance of Dr. Cowan's writings, but it is indeed surprising, and may be regarded as a remarkable instance of the slowness with which valuable truths sometimes make their way in the profession, that since the publication of Dr. Cowan's papers, many good books and lectures on auscultation and the diseases of the respiratory organs have appeared in our language, which contain no allusion to the researches of Dr. Cowan, or of the French writers on the expiratory murmur, of the diagnostic value and almost existence of which the authors seem to be quite unaware.

(6.) There is not much new in those precepts for performing auscultation; similar rules have been again and again laid down by lecturers and writers on the subject, and probably most persons would after a time come to find them out for themselves. But the student cannot be too soon impressed with the necessity of attending to them. Carelessness in the examination, inattention to the mode of breathing of the patient, and preconceived views as to what is to be heard, render the stethoscope in the hands of many not merely useless, but positively mischievous.

(7.) The preference given by some to mediate over immediate auscultation, is probably in a great degree owing to their being more accustomed to employ it; undoubtedly the object may, in the great majority of cases, be attained equally well by the latter mode. The reader will see the case stated for and against the stethoscope with much ingenuity by M. Andral, in the note referred to in the text, and by Dr. Williams in the article Stethoscope of the Cyclopædia of Practical Medicine. There is an advantage attending the employment of immediate auscultation, which M. Andral has not remarked—the greater facility with which in an examination the ear can be passed over every point of an extensive surface. Thus, in pneumonia, in pleurisy with effusion, &c. every part of the posterior and lateral regions of the chest may be successively examined in a shorter time, with less annoyance to the patient, and I think more accurately, with the naked ear than with the stethoscope. I may remark, that in some cases where the respiratory murmurs were naturally very feeble, I have found the expiratory in particular much more perceptible by immediate than by mediate auscultation; some persons also whose attention I have directed to the expiratory sound, have found it easier to recognize it with the naked ear than with the stethoscope.

(8.) The expiratory sound, as the author has observed, was first recognized in the pathological condition—in tuberculization of the lungs—where it is much developed, and soon assumes the bronchial character. Some persons appear to have only observed it in those circumstances, and to have hence concluded that it was essentially bronchial or *blowing;* others appear to have fallen into the same error by theorizing on its mode of production. The able writer in the British and Foreign Review already referred to, in concluding some observations on this point, expresses his concurrence in M. Fournet's account of the nature of the expiratory murmur, in the following emphatic language:—"The question is neither to be decided by authority, nor by an appeal to *a priori* notions on the physical play of an organ, of the intimate structure of which nothing is in reality known; it is a question of pure observation. Let the observer place his ear to the chest of healthy subjects, think neither of physics, nor of chemistry, nor of written dogmas, but apply his mind to perceive his own sensations, and he will invariably find that (unless when, as is not unfrequently the case, it is inappreciable by the senses,) the *expiratory murmur* possesses all the *softness, gentle breeziness, and freedom from bronchial character,* which belong to its predecessor in the rhythm of respiration."

(9.) Dr. Williams asserts, on the contrary, that "*over the space of two or three inches on each side of the top of the sternum,* between the scapula and sometimes *in the axillæ,*" the respiration is naturally bronchial; and this opinion has been adopted from him by Dr. Spittal and other writers. It may be useful to quote here what Laennec himself says on this point, which indeed almost coincides with the statement of M. Fournet; after remarking that this modification of the respiratory sound may be perceived over a great part of the neck, he says, "in *certain subjects*, especially if very lean, the respiration possesses something of this character when examined *over the sternum* and *at the roots of the lungs*, that is, between the scapulæ, and particularly near the upper and inner angle; but here the bronchial sound is not so readily distinguished, because of its intermixture with the common respiratory or vesicular murmur."—(Forbes's Laennec, 3rd ed. page 34.)

(10.) It is obvious, that in order to avail ourselves of those slight shades of difference in the respiratory murmurs at corresponding points of the two sides of the chest, by which we may be most materially aided in the detection of the first inroads of disease, we must be completely satisfied that such differences do not exist naturally. The question therefore considered in this paragraph, comes to be one of very great importance in practice. Unfortunately, the experience of so accurate an observer as Dr. Stokes is in this instance directly the reverse of that of M. Fournet. After stating that of the different signs of incipient phthisis, none is more important than *feebleness* of respiration, he observes, "I have found that in many individuals there is a natural difference between the intensity of the murmur in either lung, and in such cases, with scarcely an exception, the murmur of the *left* is distinctly louder than that of the right."* The reader will remark the complete discrepancy between this and the statement in the text.

(11.) A plate showing the division of the trachea, and the distribution of the larger bronchi, is given in the original; but as the reasoning, whatever it may be worth, is easily intelligible without this, I have omitted it.

As a proof of the facility with which this kind of evidence can be applied to either side of the question, and therefore, of how little value it really is in its determination, see the conclusion at which Dr. Phillipp (Berlin) arrives in following the same route: "The singular fact that the *respiration was always a little blowing at the upper part of the right lung, and not at the left*, has been familiar to me for years. I have recently made a number of dissections of the lungs, to ascertain whether this fact could be explained by their anatomical structure." He then proceeds to describe the size, length, &c., of the bronchi on each side, in much the same manner as M. Fournet, and concludes that "there are three circumstances which render the respiration more blowing on the right side: 1^0. proximity of its bronchial tubes to the trachea; 2^0. their straight course; 3^0. their greater size."†

(12.) The assertion of M. Fournet, that the normal resonance of the voice is the same in the corresponding parts of the two sides of the chest, is also contrary to the experience of some of the most accurate observers. Thus, the writer in the Review already quoted refers to the opinions of Sir James Clarke and M. Louis, that this resonance is greatest opposite the origin of the right bronchus, and remarks, that Dr. Stokes incidently mentions his belief that a similar superiority prevails over the entire of the right side of the thorax; (see note at page 397 of Dr. Stokes's work on diseases of the chest); others, however, as for example, Dr. Williams, appear not to have recognized any difference between the two sides, (see page 33 of the last edition of the Rational Exposition, &c.)

(13.) This *sound* of *pulmonary compression*, as it is called, was long since described by Dr. Williams, who had observed it in the same circumstances as M. Fournet, cases of compression or of solidification of the pulmonary tissue; "the inspiration," says he,

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* Treatise on the Diagnosis of the Diseases of the Chest, page 394.

† *Phillipp on the* Diagnosis of the Diseases of the Lungs, &c., page 32.—Berlin, 1836.

"which is loud enough at first, is abruptly arrested before the act is complete, and is stopped with a kind of *hitch*." It does not seem to have been much attended to by others; and yet it is at times of considerable value in practice. I have had an opportunity of studying this sign in several cases of pleurisy with effusion, the only disease in which I have ever observed it. In such cases, by indicating sometimes the *degree* of effusion already formed, sometimes the commencement of the absorption of the fluid, it proves an useful auxiliary in reference both to prognosis and treatment.

(14.) There is in Dr. Spittal's book a good account of the metallic signs and an ingenious explanation of the mode of production of the tinkling sound, in which he has anticipated the views of Beau, Fournet (see hereafter Chap. VIII.), and other French writers on the subject. The conditions necessary for the production of these phenomena are however by no means yet accurately determined. Dr. Williams thinks, that the metallic tinkling may occur and accompany both the voice and cough in simple pneumothorax without either liquid effusion or perforation of the pleura. May it not be, as Dr. Spittal suggests, that differences of opinion as to the physical cause of metallic tinkling have resulted from some writers confounding different metallic phenomena under this name? It is generally in tubercular cavities of great size that the metallic signs have been observed. Dr. Stokes remarks that in several of his cases the cavities were multilocular, and asks—can this condition have any effect in producing the metallic sounds? A short time since he himself exhibited at the Pathological society in Dublin, a case of tubercular cavity in the lung, where the metallic phenomena were said to have been well marked, and yet neither of the preceding conditions existed—it was neither very large nor multilocular; but there did exist a very peculiar physical condition of it, and one probably very favourable to the production of certain forms of metallic sound—its anterior wall, by which alone it was separated from the parietes of the chest, was formed of the pleura, which was here converted into a sheet of bone. There was not, however, any metallic *tinkling* in this case.

(15.) Pectoriloquy was one of the stethoscopic signs that soon became well known, and its importance was for a long time greatly overrated. Dr. Forbes, indeed, very early formed a just estimate of its value. The opinion of Dr. Stokes may, I think, be regarded as that of the majority of practitioners in this country on the subject: "as a sign of phthisis," says he, "pectoriloquism has little value. Its occurrence in cavities of all kinds, ulcerous or not, its varieties, its similarity to morbid bronchophonia, often so great as to make it difficult or impossible to distinguish them; its existence as a natural phenomenon in the upper portions of the lungs of many individuals; and its total absence in cases presenting every apparent physical condition for its existence, have long made me consider it as the least important and most fallacious of all the physical signs of phthisis."*

(16.) It will be seen by the following extract from the work of Dr. Stokes, which here also speaks, I think, the general opinion of the profession, that similar results have been long since arrived at here. With respect to egophony, after remarking that the egophonic modifications of voice in pleurisy are numerous, he goes on to say: "in many instances we never find them, and even when present they are extremely inconstant, and, taken alone, have but little value in diagnosis. It must always be recollected that between the egophonic sounds and those from hepatization, there is often the closest resemblance; indeed in a few cases of pneumonia in the stage of resolution, I have found an almost perfect egophonia: these signs too are frequently absent, and may even mislead from the circumstance that some persons have a voice naturally egophonic;" (page 496).

(17.) The auscultation of the *cough* is, I believe, at present very seldom practised here except in the case of cavities—*cavernous cough*—or for the purpose of rendering other phenomena, as *metallic tinkling*, more distinct. It has, I know, been studied by some with a view to the diagnosis of *solidification* of the lung, and rejected as of little value. The opinion, however, of M. Fournet ought to induce them to reconsider their decision.

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* On Diseases of the Chest, p. 406.

From the extracts given in the two preceding notes, it is obvious that there is little new in the author's remarks on the morbid phenomena of the *voice;* still this short article deserves an attentive perusal. The intimate connexion between the different forms of morbid vocal resonance—bronchophony, egophony, and pectoriloquy—the manner in which they are frequently blended together, the circumstances that modify their characters and influence their value, and their general importance as signs of disease, are shown here with great precision and accuracy.

(18.) This is another article that is well worth an attentive examination; indeed it is in some respects one of the most useful in the work. *Supplementary respiration* has not received from writers the systematic attention it so well deserves. Following Laennec, they usually only notice it incidentally and in a general way, but every practised auscultator is accustomed to derive from it most valuable indications in the treatment of disease. Is it not sometimes the first thing that warns us of the *extent* of a pneumonia, or the *copiousness* of a pleuritic effusion? Have we not in it, in many obscure cases, to use the author's illustration, the coming event casting its shadow before? The view taken of it as a morbid phenomena by M. Fournet, is at once comprehensive and minute, and so connected with practical considerations that it can scarcely fail to interest and instruct the student.

(19.) No one, after reading this circumstantial account of the *pulmonary crumpling sound*, can, I think, suppose that M. Fournet was misled by any of the bronchitic ronchi that sometimes coexist with the first signs of phthisis, or by a pleuritic friction sound; it must, therefore, be admitted to be a hitherto unnoticed morbid sign, for no such sound appears to have been observed by any other person. Perhaps if we consider that the strong expiratory murmur, which invariably exists in an early stage of phthisis, remained so long unobserved, we will feel less surprise that a sign which is only occasionally present (it was observed in but an eighth of M. Fournet's cases) should have equally escaped notice. Its diagnostic importance in the earliest stage of phthisis, not indeed in itself but in its connexion with other signs, will be seen in the 2nd part of the work.

(20.) It is otherwise with respect to the *dry* and *humid crackling;* these signs have been observed, there cannot I think be a doubt of it, by all who have given much attention to the auscultatory phenomena of the first stage of phthisis, though a different mode of production has usually been assigned to them, and their course has not been traced to the same extent or with the same care. The passages referred to in the author's note prove this as regards Sir James Clark, M. Andral, and Hirtz; and the following extract from Dr. Stokes' work shows that he had not only noticed these signs, but traced their connexion with the other ronchi of phthisis, and followed them throughout their whole course, though he differs from M. Fournet in ascribing their production to irritation or inflammation of the parenchyma of the lung. After enumerating as signs of irritation of the parenchyma in the early stage of phthisis, the *crepitating rales*, feebleness of respiration, and dullness of sound, and observing that of these the first alone can be properly said to indicate parenchymatous inflammation, he makes the following important remark: "unlike the rale of pneumonia, this hardly ever disappears, to be replaced by bronchial respiration, but *passes imperceptibly from the finest crepitus to the gurgling of anfractuosities*" (page 393); and again: "in general nothing can be more gradual than the transition from the crepitating to the muco-crepitating rales, from these to a large mucous rattle, which passes into the *rale of anfractuosities*, and ultimately the gurgling of a cavity" (page 404). But it detracts not from the merit of M. Fournet, or the usefulness of his researches, that these sounds had been already observed by others. The care with which he has determined their physical characters, traced their progress, and ascertained their seat and mode of production, as well as the extent and accuracy of his observations, give these signs a very different diagnostic value from what they could have had, as long as they were supposed to depend on occasional bronchitic or pneumonic complications. However familiar the ear may have been with those sounds, the mind could not heretofore have taken them as a guide with the same certainty or the same security.

(21.) This analysis of the characters of the *ronchus* of *congestion* will doubtless appear absurdly minute to many of my readers, and it must be admitted that such differential descriptions may easily be carried to an unnecessary degree of refinement; but is it not a more common and more serious fault to err in the opposite extreme? To teach that all attempts to assign differential characters to the different ronchi is useless, and to encourage that coarse and clumsy auscultation which scarcely perceives a difference between the primary crepitus of pneumonia and the mucous ronchus of catarrh.

(22.) This statement with respect to the usual seat of a *low degree* of the friction sound, and the important consequence deduced from it with respect to the diagnosis of tuberculization of the lung, is scarcely reconcileable with the experience of our best observers. Dr. Stokes has never found the physical signs of pleuritis in the earlier periods of phthisis. "It is in the advanced stages, when the upper lobe contains ulcerated tubercle, that the frottement of Laennec is *sometimes discovered in the mammary, lateral, or postero-inferior portions.*" And in another place, speaking of pleurisy, he states that he never found the friction sound in the acromial or supraspinous regions, and but once below the clavicle, in a case of aneurism of the innominata with pleuritis of the upper portion of the chest. "The rarity of these signs in the upper portion, he adds, is explicable by the less degree of motion of the pulmonary on the costal pleura" (diseases of the chest, p. 470).

(23.) Writers still continue to enumerate the *friction sound of ascent and descent* among the signs of *interlobular emphysema*, but I believe most observers here have now come to the same conclusion respecting it as that stated in the text.

(24.) "Until very lately, I had believed and taught," says Dr. Stokes, "that the friction sounds were always accompanied by clearness on percussion, or with a slightly diminished resonance, pulmonary expansion pure or mixed with rales being always audible. But I have lately witnessed a case of empyema, in which, although *great and universal dullness of the side existed*, the friction phenomena were audible, and even perceptible to the patient, in the postero-inferior and lateral parts of the chest. They may then coexist with extensive liquid effusion." In a similar case M. Fournet appears to have found that a portion of the lung was retained in contact with the side, by bands of false membrane—(see proposition 29th of this article.)

(25.) The same remark may be made with respect to this ronchus, as to the friction sound of ascent and descent; we find it occasionally mentioned in books as a sign of pulmonary emphysema, but no person here, I believe, thinks of it in practice.

(26.)* The extracts previously given from Dr. Stokes's work prove, that he had long since come to similar conclusions with respect to the different forms of morbid vocal resonance. An equally accurate observer, Dr. Corrigan, takes the same view of those phenomena, which indeed I think may be considered that of at least the Dublin school. "These observations," says Dr. Corrigan, "prove that there is no difference in kind between bronchophony and pectoriloquy. *The difference is only in degree.*" Again: "there is a *singular kind* of bronchophony heard in some cases of pleuritic effusion, to which the name of egophony is given, &c." (Clinical lecture, Medical Gazette, March 12th, 1841.) Dr. Williams, however, I should observe, still continues to maintain a very different opinion with respect to these signs, especially pectoriloquy. In his article on phthisis, in the Library of Medicine now publishing, we find the following: "*Pectoriloquy is another very striking sign of a cavity in the lungs.* Its value was, perhaps, overrated by Laennec; but we think it has been neither appreciated nor understood by subsequent writers." After describing the mode in which it is produced, he proceeds: "the sound is not a mere vocal resonance, like the bronchophony from consolidation, which is often as loud or louder, and may seem to pass up the tube quite as much; but it is an articulate though indistinct speaking.........The circumscription of pectoriloquy is another of its peculiar characters, and by this it may generally be distinguished from the loud bronchophony of condensed lungs, which is diffused over some extent of surface."

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* The second paragraph of note 17 should have formed part of this note.

(27.) I have already, in note 14, alluded to a case in which a different physical condition from any of those stated here, namely, remarkable density of its parietes appeared to be chiefly instrumental in producing metallic sounds in a tubercular cavity.

(28.) It is not my intention to prolong, by any remarks here, a chapter which most persons will doubtless deem unnecessarily prolix; I am only anxious to direct the particular attention of the student to the new and valuable source of diagnosis it reveals. He will scarcely find a trace of it in any English writer; indeed it could only originate in the separate study of the two periods of respiration.

(29.) The following signs of a "very advanced state of emphysema of the lungs should be added: displacement of the heart; descent of the diaphragm and the liver, and consequently clearness of sound in the postero-inferior portions of the chest, and in the region of the liver anteriorly—(see Stokes on emphysema of the lungs).

Dr. Stokes differs from M. Fournet, and indeed from most writers, in his account of the state of the intercostal spaces in this disease. "When we examine," says he, "the intercostal spaces in this affection, even *after great dilatation of the chest has occurred,* we see them, so far from being obliterated, *deeply marked,* and the *muscular fibres acting* powerfully, so as to elevate the ribs, and assist in the imperfect inspiration."

(30.) Dr. Stokes had been long since led, as well from observation as from analogy, to believe in the existence of a stage of pneumonia, antecedent to that indicated by the crepitant ronchus (the 1st stage of Laennec); but the anatomical characters, as well as the stethoscopic signs of this stage, as described by him, are very different from those of M. Fournet's stage of congestion. The pulmonary tissue, according to Dr. Stokes, is at this period "drier than natural, not at all engorged, and of a bright vermillion colour, from intense arterial injection." He found this condition in the upper portions of lungs, in the middle and lower portions of which Laennec's first and second stages existed—in cases of pneumonia, where death occurred from other causes—and in subjects who died of acute phthisis, with severe inflammatory symptoms. It will be remarked, that the anatomical characters assigned by M. Fournet to this stage of the disease—the *moist, congested* condition of the pulmonary tissue, are derived from the examination of a single case. Though Dr. Stokes hesitates to pronounce positively on the subject, his observations lead him to think, that an intense puerility of respiration in the affected part will be found to be the chief physical phenomenon at this stage of the affection. After referring to some of the facts on which this opinion was founded, he adds: "from these and many other observations I would conclude, that we may diagnosticate the first stage of pneumonia, by the sudden occurrence of a local puerility of respiration, combined with fever and excitement of the respiratory system."

(31.) The opinion of Dr. Williams, that the supervention of the 3rd, or suppurative stage of pneumonia, is to be inferred from the *duration of the disease and the general symptoms,* rather than from the *physical signs**, seems to be that of the majority of the profession. Dr. Stokes and M. Fournet however agree in thinking that this diagnosis is sometimes possible, and that the occurrence of interstitial suppuration is characterized *by a peculiar* form of mucous ronchus. M. Fournet makes its coexistence with *inspi-*

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* Library of Medicine, vol. 3, p. 142.

ration only the chief differential character of this ronchus. Dr. Stokes describes it as a sharp and peculiar muco-crepitating rale, *combined with bronchial respiration.*

Dr. Stokes appears to have first recognized the occurrence of *contraction of the chest* as a consequence of pneumonia. Though it usually corresponds to an indurated and impervious state of the pulmonary tissue, it may coexist, he remarks, with a gradual and ultimately perfect resolution of the disease.

(32.) M. Fournet has scarcely noticed what Dr. Stokes considers the most valuable of the physical indications—the signs of eccentric displacement: of those the most important is the displacement of the heart.

(33.) Dr. Williams seems to think with M. Fournet that auscultation is of little value in the diseases of the larynx or trachea. The only useful application of it to which he alludes is in incipient croup:—The sonorous inspiration of croup is audible, he says, through the stethoscope applied to the throat or upper part of the chest, *before it can be heard by the unapplied ear.*" Dr. Stokes on the other hand states that he has seen, in cases of laryngeal disease, enough of variation, both in the passive and active signs, to persuade him of the importance of the subject. With respect to percussion in laryngeal affections, he says he has not made sufficient observations to announce the alterations in the sound produced by disease; but he has seen enough to conclude that disease modifies the sound. The stethoscopic signs are the altered character of the laryngeal sounds of inspiration and expiration, and the existence of a rale in the larynx. This rale is said not to exist in all instances, but to be, when present, extremely characteristic. *It may exist on one side of the larynx without being perceptible on the other,* as if it there corresponded to a circumscribed ulceration; (see Stokes on diseases of the lungs, page 248, &c.) One of the most interesting applications of the study of laryngeal auscultation, made by Dr. Stokes, is to the diagnosis of intro-thoracic tumours; (see Dublin Med. and Chem. Journal, 1834).

(34.) The theory of M. Beau appears to have met even a less favourable reception here than in France. This was to be expected. So paradoxical a view, however ingeniously brought forward, was not likely to find at first supporters in this country, more especially when contrasted with the simple, obvious, and seemingly satisfactory explanation adopted by Laennec; and perhaps it has been rejected by most persons almost without an examination. One ingenious inquirer, indeed, Dr. Spittal, has investigated the subject, and, with a slight modification of M. Beau's opinion as to the seat of the *guttural* sound, has been led by new and well contrived experiments to nearly the same conclusions; (see a paper read at the meeting of the British Association in 1838, and published in the Edinburgh Med. and Sur. Journal for Jan. 1839). M. Beau, adopting the view of Dr. Spittal, that the guttural sound is produced not by the impulse of the air against the soft palate but by its passage across the glottis, has recently renewed his inquiries on this subject, and in a series of elaborate papers, published in the Archives Generales for 1840, has endeavoured to show the applicability of his theory to explain the various physiological and morbid sounds produced in the respiratory apparatus. The reader will see a good analysis of two of those papers in the Medico-Chirurgical Review, Nos. 67 and 68 for January and April, 1841.

END OF PART I.